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GEOGRAPHY.

CONGRESS AND THE NORTH POLE.

AN ABSTRACT OF ARCTIC LEGISLATION IN THE CONGRESS OF THE UNITED STATES.

BY CAPT. H. W. HOWGATE, U. S. A.

IV.

THE POLARIS EXPEDITION.

HOUSE OF REPRESENTATIVES, March 8, 1870.

The Hon. J. E. Stevenson, of Ohio, introduced a joint resolution (H. R., No. 187), relative to a voyage to the Arctic regions, which was read a first and second time, referred to the Committee on Appropriations, and ordered to be printed.

IN SENATE, March 25, 1870.

Mr. Sherman, of Ohio, introduced a similar resolution, (S. R., No. 166,) which was read twice by its title, referred to the Committee on Foreign Relations and ordered to be printed.

April 19, 1870.

Mr. Sumner reported the resolution with an amendment.

May 2, 1870.

The Committee on Foreign Relations reported the joint resolution with an amendment, which was to strike out the preamble, and all of the original resolution in the following words:

WHEREAS, Capt. C. F. Hall is an enterprising and experienced explorer, who has made two successful voyages in the Arctic regions, and

WHEREAS, he desires, in the interests of science and for the material advantages of his country, to make a voyage of exploration and discovery under the authority and for the benefit of the United States, therefore

"*Be it Resolved*, That the President be and he is hereby authorized to furnish a naval or other steamer, and if necessary, a tender for a voyage into the Arctic regions under the control of Capt. C. F. Hall.

Section 2. And be it further

Resolved, That the sum of one hundred thousand dollars be, and the same is hereby appropriated out of any funds in the Treasury, not otherwise appropriated by law, which sum, or so much thereof as may be requisite, shall be paid out on the order and expended under the direction of the President in proper and necessary expenses of said voyage.

And to insert in lieu thereof:

Be it Resolved, That the President of the United States be authorized to organize and send out one or more expeditions for Arctic explorations toward the North Pole, and to appoint such person or persons as he may deem most fitted to the command thereof; to detail any officer of the public service to take part in the same, and to use any public vessel that may be suitable for the purpose; the scientific operations of the expeditions to be prescribed in accordance with the advice of the National Academy of Sciences, and that a sum of one hundred thousand dollars, or such part thereof as may be necessary, be hereby appropriated out of any moneys in the Treasury not otherwise appropriated, to be expended under the direction of the President.

Objection being made to its present consideration, the joint resolution was passed over. * * * * * *

May 23, 1870.

Mr. Sumner offered the amended resolution as an amendment to the legislative, executive and judicial appropriation bill, and said that he had no desire to debate the proposition.

Mr. Williams, (Oregon). "I think we had better vote it down."

The question being put, it was decided that the amendment appeared to be rejected; and a division was called for.

Mr. Sumner. "As there is to be a division, I desire to explain to the Senate the origin of this amendment. It will be remembered that the Senator from Ohio, the Chairman of the Committee on Finance, as long ago as March 25th, introduced a joint resolution relative to a voyage to the Arctic regions, which, on his motion was referred to the Committee on Foreign Relations. The Committee took this resolution into careful consideration; they were occupied upon it at

several meetings; they heard witnesses. Among others they listened for a long time to Capt. Hall, and also to Dr. Hayes, of New York, both of them eminent Arctic explorers.

The conclusion that the Committee came to was, that it would be in the interest of science and for the dignity of this Republic that it should countenance such an expedition, but on the evidence before it the Committee hesitated to choose between these two explorers.

They were unwilling to hold the scales. They had before them strong testimony in favor of each. For instance, I have here a file of papers, all of which I will not read. One, for instance, is a letter from the eminent head of the Coast Survey, Mr. Pierce; it is short and I'll read it:

CAMBRIDGE, MASS., April 9, 1870.

MY DEAR SIR:—I cannot understand how giving to Capt. Hall takes away from Hayes. As to myself, I think the cry of North Pole is one of those popular notions through which much good is done to the service of knowledge. The strong letter of Prof. Henry, is to me sufficient justification for the support of Capt. Hall, and it seems to me that he is well fitted to do good work, and tha the attack on him is an unprovoked outrage. That he has defects, and especially in scientific culture is obvious enough. But he is modest and acknowledges his own defects, at the same time that he makes claims which seem to me in my poor judgment, as not unworthy of regard. I am not aware that any expedition has yet returned from the Polar regions without bringing back its money's worth in increase of knowledge, and Capt. Hall's plans seem to give good promise of just as valuable returns. But I would also be glad to see Dr. Hayes, or anybody else, embarked in enterprizes of their own.

The Polar regions are wide enough for many explorers, and no harm would come from a little rivalry. Let them both go; the cost is nothing for such a nation as our own. Yours very truly,

BENJ. PIERCE.

That letter I may say, is the voice of science itself. Prof. Pierce is known, not only in our own country, but abroad, as one of the most eminent and accomplished scientific characters that our country has ever produced, and here you have his testimony.

Then comes a series of resolutions presented to the Senate by the Senator from New York, (Mr. Conkling.) adopted by the Geographical Society, April 11th, 1870, as follows:

ROOMS OF THE GEOGRAPHICAL SOCIETY, N. Y., April 11, 1870.

The following resolutions are recommended by the Council, and were unanimously adopted at the regular monthly meeting of the Society.

Resolved, That it is eminently desirable that an expedition should be fitted out by the Government, for Arctic exploration and the discovery of the North Pole.

Resolved, That in view of the great perils and difficulties which attend any attempt to penetrate the Arctic regions in vicinity of the Pole, and as the objects

to be attained are scientific, the expedition should be commanded by a Naval Officer of Arctic experience, having under him an efficient scientific corps, so that an amount of scientific information may at least be gathered, as will reflect honor upon the country, and justify the fitting out of the expedition.

Resolved, That, without assuming to dictate to whom the command of it should be intrusted, we would call attention to the fact that Dr. Hayes has received the gold medals of the Royal Geographical Society of London; the Imperial Geographical Society of Paris; the endorsements of the Imperial Societies of St. Petersburg; the Geographical Society of Berlin; the Royal Academy of Sciences of Brussels, and the Geographical Society of Italy, and having in his last expedition, though provided with very insufficient means, reached nearer to the Pole than any previous explorer, except Parry, he is, in the opinion of this Society, to be regarded as the most able, eminent and experienced of living American Arctic explorers.

Resolved, That copies of these resolutions be forwarded to both Houses of Congress.

Thus, sir, the Committee had before them testimony in favor of these two distinguished explorers. Hesitating to decide between them; not willing to take that responsibility, but at the same time uniting in the conclusion, and I think they were unanimous, that such an expedition should be attempted; that it belonged to the United States, in the interest of commerce, as a representative of science, for the sake of humanity, for the advancement of knowledge, to see that such an expedition should be attempted, they directed me to report a bill as a substitute for that which had been referred to the Committee on the motion of the Senator from Ohio. At a subsequent day, following again the instruction of the Committee, I gave notice of the motion which I have now made, to move that bill as an amendment to this appropriation bill. Such, sir, is the brief history of this proposition, and how it comes before the Senate at this time, and the simple question is, whether you will hesitate in this work.

Already the great powers of Europe, one by one, have attempted this discovery. England, Germany, Denmark, and we are now told that France is planning an expedition.

Shall the Great Republic alone stand aloof? Shall we, who have a greater interest in this discovery, and in the extension of a knowledge of this hemisphere than any other power, shall we be the only one that shall not participate in the work? Mr. President, I am not disposed to enlarge this topic; Senators will all understand it without further explanation. The amendment is simple. It refers the whole matter to the President of the United States, empowering him, in his discretion, to equip one or more expeditions. I think the work ought to be done and I hope the Senate will now unite in it."

The question being put there were, on a division—Ayes 21, Nays 16.

Senators McCreery (Ky.), and Trumbull (Ill.), called for the yeas and nays, which were ordered, and resulted—yeas 25, nays 25.

The Vice-President, Mr. Colfax, voted in the affirmative, and the amendment was agreed to.

HOUSE OF REPRESENTATIVES, July 9, 1870.

The Senate amendment was agreed to by the Conference Committee, substituting the sum of fifty thousand dollars for the amount originally proposed by the Senate.

The act was approved by the President, July 12th, 1870, and on July 20th, Capt. Hall was designated as the Commander of the expedition.

The U. S. Steamer, "Periwinkle," 387 tons, was selected for the expedition and re-christened the "Polaris" by Capt. Hall. She sailed from Washington June 10th, 1871, and from New London July 3d, 1871. The history of the expedition is too fresh in the memory of the American public to justify repetition here. It is only necessary to state, that after the death of Capt. Hall, no determined effort was made to get north of the winter quarters selected by him, and that on attempting to return home the "Polaris" was caught in the ice and sunk off Littleton Island, Oct. 15th, 1872. Part of her crew were picked up April 30th, 1873, in Lat. 53° 35′ N., off Grady Harbor, Labrador, by the bark Tigress of Newfoundland, after drifting upon an ice-floe from the date of the disaster. The remainder, after wintering on Littleton Island, were picked up by the steamer "Ravenscraig," of Dundee, Scotland, June 23d 1873. in Lat. 75° 38′ N., Long. 65° 35′ W.

The Sundry Civil appropriation bill for the fiscal year ending June 30th 1875, contains the following clause, providing a suitable recompense for the parties affording relief to the shipwrecked explorers.

* * * * * * *

"The Secretary is hereby authorized and directed to make, out of any money at his disposal available for that purpose, sufficient and appropriate compensation and acknowledgment to the owners, officers and sailors of the British whaling and sealing steamers which contributed to the rescue of the survivors of the "Polaris," for such rescue, and any loss sustained by reason thereof, and for their humane and hospitable reception, entertainment and transportation until they were all finally and safely landed in Newfoundland and Scotland."

* * * * * * *

In the Deficiency Appropriation bill for the year ending June 30th, 1875, the following passage occurs:

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"For printing illustrations of the results of the Polaris expedition, under the direction of the Secretary of the Navy, fifteen thousand dollars."

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An act for the relief of the survivors of the "Polaris" was passed March 3d, 1875. as follows:

Be it Enacted, &c., That the proper accounting officers of the Treasury be authorized and directed to pay, out of any money in the Treasury not otherwise appropriated, to the survivors of the "Polaris," engaged in the Arctic exploration under command of Capt. Charles F. Hall, their widows, or minor children, and in the order named, a sum of money in addition to that already paid, equal in amount to one year's pay which each would have been entitled to respectively

if continued in the service, under the rules and regulations prescribed by the Secretary of the Navy for said exploring expedition; and that the sum of three hundred and sixty dollars each, be paid to Joe Eberling and Hans Hendrick, Esquimaux, who rendered valuable assistance to that part of the ship's crew rescued from the ice-floe, on or about the 30th day of April, 1873; said payment to be made direct to each individual claimant, upon satisfactory evidence of his identity,

Provided, That if any sale, assignment, or transfer shall be made of any interest in the gratuity provided by this act, the amount so assigned shall revert to the Government of the United States.

The narrative of the Polaris expedition proved such an interesting work, that a new edition was authorized by Act of Congress, June 14th, 1878, in the following words:

June 14, 1878.

Be it Enacted, &c., That the Public Printer be, and he is hereby authorized to print from the stereotyped plates, now in his possession, such number of copies of the Narrative of the Polaris' expedition as may be subscribed and paid for within such reasonable time as the Public Printer may designate,

Provided, That the whole number printed shall be sold at the cost of publication with ten per centum additional, and no greater number shall be printed than shall have been subscribed and paid for prior to going to press thereon, and authority is hereby given to the Public Printer, to procure the material, engravings and lithographs necessary for the publication of the work, and it shall be the duty of the Public Printer to cover all moneys received for copies of the works into the Treasury, making a report thereof in his next annual report.

V.

THE BENNETT POLAR EXPEDITION.

Mr. James Gordon Bennett, of the New York *Herald*, having bought the well known Arctic steam yacht "Pandora," for the purpose of making an attempt to reach the Pole *via* Behring's Strait, was desirous of having her sail under the American flag, and the command of an officer of the U. S. Navy. The necessary legislation for this purpose was procured by the passage of the following Act of Congress, which was approved by the President, March 18th, 1878.

"WHEREAS, James Gordon Bennett, a citizen of the United States, has purchased in Great Britain a vessel, supposed to be specially adapted to Arctic expeditions, and proposes, at his own cost, to fit out and man said vessel, and to devote her to efforts to solve the Polar problem; and

WHEREAS, it is deemed desirable that said vessel, while so engaged, shall carry the American flag and be officered by American Naval Officers, therefore

Be it Enacted, &c., That the Secretary of the Treasury be authorized to issue an American register to said vessel by the name of "Jeannette," and that the Presi-

dent of the United States be authorized to detail, with their own consent, commissioned, warrant, and petty officers of the Navy, not to exceed ten in number, to act as officers of said vessel during her first voyage to the Arctic seas,

Provided, However, That such detail shall be made of such officers only as the President is satisfied can be absent from their regular duties, without detriment to the public service.

The "Jeannette" is announced to sail in the early part of 1879, from San Francisco, under command of Lieut. Geo. W. DeLong U. S. N., a young officer of marked ability and enterprise, and who has had some experience in Arctic work along the Greenland coast, in searching for the Polaris' survivors in 1873.

Past efforts to attain high latitudes *via* the Behring's Strait route have not been sufficiently successful to warrant very sanguine hopes of future success by that route, but the "Jeannette" will be followed by the best wishes of the friends of Arctic exploration in Europe and America, and if she fails in accomplishing all that is desired in the solution of the Polar problem, it may be safely assumed that it will not be from any lack of effort or energy on the part of her owner or of her commander.

VI.

POLAR COLONIZATION.

Although not properly coming under the head of actual legislation, the Congressional action upon the Colonization question has been of a sufficiently positive nature to justify a brief reference to it in these pages.

CONGRESSIONAL ACTION.

The first formal action taken in Congress, in reference to the measure, was the introduction of the following bill, which was offered in the House of Representatives on January 8th, 1877, by Hon. Morton C. Hunter, of Indiana:

A bill to authorize and equip an expedition to the Arctic seas.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the President of the United States be authorized to organize and send out one or more expeditions toward the North Pole, and to establish a temporary colony, for purposes of exploration, at some point north of the eighty-first degree of north latitude, on or near the shore of Lady Franklin Bay; to detail such officers or other persons of the public service to take part in the same as may be necessary, and to use any public vessel that may be suitable for the purpose; the scientific operations of the expedition to be prosecuted in accordance with the advice of the National Academy of Science; and that the sum of fifty thousand dollars, or such part thereof as may be necessary, be hereby appropriated out of any moneys in the Treasury not otherwise appropriated, to be expended under the direction of the President:

Provided, That no part of the sum so appropriated shall be carried to the surplus fund or covered into the Treasury until the purpose of the appropriation

shall have been completed, but may be applied to expenses of said expedition incurred during any subsequent year that said expedition may be engaged in its duties.

After a second reading the bill was referred to the Committee on Naval Affairs and ordered to be printed. On February 9th, 1877, it was introduced in the Senate by Hon. Henry L. Dawes, of Massachusetts, read twice and referred to the Committee on Naval Affairs. On February 22, of the same year, it was reported favorably from the House Committee on Naval Affairs by Hon. Benjamin A. Willis, of N.Y.,and recommitted. No further action was taken on the bill bythe 44th Congress, but soon after the meeting of the 45th Congress it was again introduced in both Houses by the same members and in each referred to the Naval Committee. On the 22d of January, 1878, Mr. Willis, on behalf of the Naval Committee of the House, submitted a favorable report.

On the 13th of February, 1878, Hon. A. A Sargent, from the Naval Committee of the Senate submitted as the report of that Committee the House Committee's report, concurring in its conclusions and recommending the passage of the bill.

On the 18th of June, 1878,an effort was made to obtain action on the bill, Mr. Danford, of Ohio, moving in the House to suspend the rules and pass it. The bill was read and the question being put there were, ayes, 65, noes 56. So (two-thirds not voting in favor thereof) the rules were not suspended, and the bill went over to the present session, during which it is hoped that favorable action will be taken in compliance with what is believed to be the wishes of the commercial, as well as the scientific interests of the country. The Chambers of Commerce and Boards of Trade of nearly every large city in the United States, have requested their Representatives in Congress to favor the bill, and hasten its passage, while scientific associations have urged the same request with gratifying unanimity.

PHYSICS.

THOUGHTS ON OUR CONCEPTIONS OF PHYSICAL LAW.*

BY PROF. FRANCIS E. NIPHER, ST. LOUIS, MO.

In the short time at my disposal, I wish to point out some reasons for the more general cultivation of a certain cardinal virtue which is so rare that I fear it has no name. Perhaps the words, *Intellectual Modesty*, would come as near as any others in expressing what I mean. The world is very full of people who are ready to make assertions upon subjects which are evidently too difficult for them —in many cases too difficult for any one—to handle with any degree of certainty; and it doubtless often happens that some who have meditated studiously

*An adderss before the Alumni of the State University of Iowa, June 19th, 1878; delivered at Kansas City, December 23d, 1878.

for years upon some such subject, arriving at no satisfactory conclusion, are regarded as objects of profound commiseration by others, who rush upon conclusions like the unthinking horse into the battle. It is as natural that people should thus differ, as that some should have darker skins, taller frames, or more irritable tempers than others. To what extent these, and other differences which we shall point out, are blameworthy, we cannot attempt to discuss, but shall study the mental habits of men in precisely the same spirit in which we would study the habits of other animals. But I wish to show some tangible reasons for thinking that there are very few subjects upon which we can dogmatize, and that in any case it is unnecessary. I wish to advocate the cultivation of intellectual modesty, not merely because it seems to me to be one of the brightest ornaments of the human mind, but because of its vital connection with another cardinal virtue—intellectual honesty.

Perhaps this end will be best attained by considering the difficulties which are met in the investigation of any subject, when the sole aim is to find out the truth of the matter, and I have thought it proper to point out some of the difficulties to which we are subject in arriving at our conceptions of physical law.

The study of physical science has endowed the human mind with an attribute which is usually ascribed to and is thought to be characteristic of the Divine Mind. I refer to the power of prophecy. The astronomer can predict the position of the planets for generations to come, basing his predictions on the assumption—an unproved assumption—that only those causes which he has considered will act in the future, or, in other words, that the present order of things will continue. His power of prediction does not, however, extend indefinitely into the future, for there are, doubtless, many minor disturbances or perturbations, too small to be detected by the instruments which he can command, without many centuries of observation, the effects of which will become plainly apparent after the lapse of ages—that is to say, his power of prophecy is limited by his ignorance of certain facts, and, possibly, by his inability to solve the equations involved in a complete discussion of the subject.

It is for precisely the same reason that *we* cannot foretell the future destiny of every person in the world. But to a mind possessing all knowledge, and of infinite power, the one problem would evidently be as simple as the other.

We can readily imagine a being, possessing sufficient knowledge and ability, to calculate the orbits of every person now living. Such a being must know all that is to be known in regard to our mental and physical organisms, and the circumstances under which we are and will be placed. Having thus the initial stage and being able to trace succeeding events as logical sequences of the present, *such a being could predict exactly what each of us will decide to do, under the present and all succeeding circumstances—could predict how far we will be physically and mentally able to carry our resolutions into effect.*

But how awful must be the mind which could perform such a task! The most gifted mathematicians, have, after enormous labor for two centuries, given an approximate solution of the interaction of three gravitating bodies, but they

tell us that the methods used would not apply to four bodies, each of which exerted appreciable effects upon the others. How utterly beyond human power it would be to discuss the motions of the millions of chemical atoms contained in a single ounce of matter. Herschel has said that each of these particles is forever solving differential equations, which, if written out, might belt the earth.

But our imagined ideal mind must deal with the physics of our globe, and the interaction of its myriads of men. The whole phenomena of meteorology must be calculated, not only for every part of the earth, but for all time. The effect of these climatic influences upon each man, and upon the grain or other productions of his industry, must be determined. The repressing effects of political and social tyranny, and the conditions of their existence; the refreshing effects of food and sleep, and the circumstances which may sometimes prevent communities or individuals from obtaining enough of them; the moral influence of men upon each other—to come to smaller matters, the effect of the present address upon each member of the present audience—all must be taken into account in this stupendous calculation. And now, given the myriads of vibrating atoms, and whatever else may constitute a man, and the external forces which act upon him, the manner in which the atomic motions of his body will be modified, and the resulting effect upon his thoughts and decisions must be determined. The calculation must be comprehensive enough to include the thoughts and actions of all men through all time. Such a being would be able to determine, by aid of some high order of mathematical analysis, how many men will exist upon this earth five hundred years hence, would be able to locate each man, as astronomers predict the position of planets, and must be able to predict what task will then employ his hands, what train of thought will then be passing through his mind. A great famine occurs in China: it is produced by a combination of unfortunate circumstances, and the exact limit of its ravages could have been predicted, ages before.

A certain closed line drawn upon the earth, would mark out the area where 25 per cent. of the inhabitants would starve to death. Outside of this area would lie a belt of country, where 20 per cent. would die, and in this manner the whole of the melancholy facts could be represented. The discussion of the distribution of people and food, the means of transportation, the physical strength and wealth of individuals affected, and other matters involved in the question, would enable an all-powerful mind to determine to what extent each individual would be affected and which ones would be strained beyond physical endurance. The position of each atom of matter in our world must be deducible, and the exact manner in which each atom moves and vibrates. Some portion of matter may repose for ages, locked in some rocky ledge. Infinite intelligence can calculate when a chance stroke from a workman's hammer may beat it loose, at what time it will be borne aloft on the fickle and inconstant winds, and when and where it will again fall, now it becomes part of some animal or plant, but everywhere its existence is recognized and its path is traced by infinite mental power.

When we consider that our earth is but a speck in this universe of universes, that untold millions of suns and worlds are scattered through space, and that all

are grasped by a knowledge equally profound, we begin to get some faint idea of the magnitude of that mind which can solve the general equations of the universe, and we can begin to realize, how comparatively insignificant, how necessarily imperfect, are our highest mental achievements.

Whether or not there be such a being as the one we have here imagined, it would be foreign to our purpose to discuss, but it seems to me that very few who talk fluently on either side of the question, have ever tried to weigh, in a calm and dispassionate manner, the awful import of the words they use.

In such a calculation as the one we have here supposed, mental philosophy would become an exact science. The intensity of mental action, the strength of different minds, and quantities of pleasure and pain would be determined. The logic of the wise and the foolish, the learned and the ignorant, the virtuous and the vicious, would be followed out to the conclusions which these minds would severally reach, under the particular circumstances in which each is placed.

Let us assume that one of the secret springs of human action is this: that in any given case we decide to do that which we then think will give us, on the whole, most pleasure or least pain, often deciding, however, to give up a greater pleasure, to be enjoyed only in the future, for a lesser one which we can enjoy immediately, precisely as we sometimes allow a note to be discounted in order that we may realize upon it at once; or, to take another case: we have in mechanics a principle known as the "principle of least action." Applied to the solar system, it affirms that each of the planetary bodies so moves, that the sum of the energy lost by counter attraction, is less than if they moved in any other way. If this law holds in the interaction of men in society, it would mean, that however erratic the orbits of individual men may be, however much trouble may come upon them, or however much they may bring upon themselves, taking men as they *are*, the sum of human trouble is less than if men *did* differently, *being* what they are. Assuming that man is wisely constructed, mentally and physically, this is merely saying, in other words, that the present order of things is a wise one.

We are hardly in a position to assert that either of these statements is really a law of social physics. They are referred to here merely to indicate the nature of the results, which could be reached by mathematical analysis if we were able to discuss the interaction of moral and mental centers of action as astronomers discuss, approximately, the interaction of worlds.

Not only are we unable to predict for an infinite future, on account of the summing up of disturbances which cannot be detected in a short time, with our means of investigation, but, as before suggested, events wholly unexpected to our partially instructed minds—apparent breaches of continuity—are liable to happen at any time. A tribe of savages, not acquainted with fire-arms, may acquire a loaded musket. In toying with it for a time they become familiar with its appearance, and, as they think, with its properties. But some day they succeed in discharging it, an event which they are powerless to bring about again by an exact repetition of the act which brought it about before. Who shall say that there are not hair triggers in the universe, upon which we may sometime stumble? *"We

* See Jevon's Principles of Science, 1877. pp. 742-748.

can imagine intelligent beings living on a world surrounded by an atmosphere of oxygen and hydrogen. So long as they were unacquainted with fire, they might live for ages in fancied security," studying the laws of the evolution of their world, and making wise predictions in regard to its future. But the production of a single spark of fire would ignite their atmosphere, and wrap them in utter destruction. "We know not at what moment immense, and to us, wholly unexpected energies may be called into action. For all that our knowledge can tell, the volume of human history may be finished during the next hour. A great explosion on the sun may scorch us into cinders in a second. The earth may be dashed to pieces and dissipated into gas, by collision with some immense meteorite. We may become involved in a nebulous atmosphere of combustible gas, which would ignite a moment later; in fact, as was so eloquently pointed out by Mr. Babbage, there is no catastrophe too great, or too sudden, to be consistent with the reign of law, and the continuity of action."

In the discussion of physical phenomena, we always ignore the greater part of the discussion, by neglecting those elements which are, or are supposed to be, unimportant. In so simple an operation as the weighing of a quantity of matter on a steelyard, we can discuss only the merest elements of the case. The student of Physics would tell you, that the weights are inversely as the lever arms, but this is far from being the whole story. During the weighing, certain parts of the steel bar are heated; other parts are cooled; still other parts retain their temperature unchanged; electrical currents are set up within its mass; its magnetism is changed; its torsion and elasticity become different—in fact, to discuss all the changes occurring within the bar during so simple an operation, would infinitely transcend the power of the most gifted men.

If we could discuss completely the laws which govern phenomena, we should find them represented, in many cases, not by the comparatively simple formulæ, which have been found sufficient for practical purposes, but by infinite series, the first terms only of which our mathematicians have been able to deduce, and our physicists to experimentally detect.

What is here said of physical problems, is also true of problems of pure mathematics. It is stated by mathematicians, "that those problems which have been solved, are but an infinitely small part of those which can be proposed, that they are all special cases, (although sometimes called general) and that if a problem were selected, at random, out of the whole number that might be proposed, the probability would be infinitely slight—that any human being could solve it."

Even those problems that have been satisfactorily solved, involve ideas that we cannot comprehend. Let us take a simple problem in Geometry. Imagine two wooden rods, or finite lines intersecting each other, and let us revolve one of them until they become parallel. Consider these lines infinitely prolonged, and let us see what becomes of these prolongations. As one line is revolved the point of intersection travels outwards. Finally the lines might seem to be parallel, but perhaps if we were to travel along the lines for a million of miles, we might come to the point of intersection. The mathematicians say, that when the lines

have become parallel, the point of intersection will be removed to an infinite distance, which is, they say, equivalent to saying that the lines will not intersect. Where in space will these lines part company? Have they ends, which the point of intersection finally reaches, and which then separate from each other? No! The lines are supposed to be without end. *However far* the point of intersection may have travelled, we may straightway regard this distance, as represented by the first term of a divergent series of an infinite number of terms, each term of which is infinitely greater than the one which preceded it. We can form an independent conception of two infinite and absolutely parallel lines, but we cannot imagine how the infinite prolongations of intersecting lines can ever separate; nevertheless, we can continue the rotation of our finite line, until it passes through parallelism, and the point or at least a point of intersection comes travelling towards us from the opposite direction.

Prof. Jevons appears to think that our difficulty in such cases, is due to an imperfect idea of infinite space.*

In the study of Physics, our most certain experimental results force us to ideas equally beyond our power of realization. It is shown beyond question, that light moves over a distance of about seven times the circumference of our earth in a single second. We must look for something marvelous in any theory which can account for so marvelous a fact. According to Newton's theory, we should have particles of light, shooting off from a distant luminous body with this immense velocity, and, falling upon a mirror, their motion would not merely be checked, but the elasticity of these light particles must be assumed to be so perfect, that they rebound with an equal velocity.

According to the undulatory theory, the light consists of vibrations of a medium which fills all space. Since the velocity of transmission of these vibrations is so great, it follows that the elasticity of this medium must be 10,000,000,000 times as great as that of the hardest steel. Space is not now regarded as a void, but as filled with a medium which, as Thomas Young remarked, "is not only highly elastic, but absolutely solid." And yet, as we walk through space, the solid atoms which compose our bodies, experience not the slightest resistance. Such ideas, although they can be conceived, cannot be realized. We have had no previous experience with materials possessing such properties, and such ideas must necessarily appear strange to us; but they are no more strange than the phenomena of light which we directly observe, and which force us to this, or to some other theory, equally marvelous. Only those who have carefully examined the subject, can realize how weighty is the evidence in favor of the undulatory theory of light; but where such stupenduous conceptions are involved, a slavish acceptance of any theory, even by them, would be in the highest degree objectionable. We are not the friends of theories, but of truth.

So in all departments of thought, we come sooner or later to depths which the human sounding line cannot pierce; we reach ideas, about which it becomes hazardous to talk, unless one courts the position of a babbler of nonsense; we

* Principles of Science, p. 767.

learn that all our "final" formulæ contain unknown quantities. As we are not infallible, we must therefore be cautious and modest.

It is not surprising then, that in the progress of our sciences, many errors of reasoning and in the interpretation of facts have been committed. You are all familiar with the ideas of Newton, in regard to the nature of light, ideas which were not in themselves absurd, which were firmly believed in by this man of such transcendent power, but which were clearly negatived by results of subsequent experiment.

It was known long ago, that rain-gauges placed above the surface of the ground, caught less rain than those placed at the surface, and it is still taught in many of our text-books, that this is due to a condensation of moisture in the lower strata of the atmosphere. This idea is not absurd, but it has been shown* that this cause produces no appreciable effect, and that the observed effect is due to the action of the wind, "which sweeps some rain out of all gauges, and most, out of those which are highest, and therefore most exposed."

Lavoisier's idea that all acids were compounds of oxygen, received a complete refutation when the constitution of prussic and muriatic acids became known. In fact, the errors of scientific men are well nigh innumerable, not because they are men of science, but because they are *men*, and we are probably justified in saying quite in general, that if the man who never committed a mental blunder be found, we shall also find a man who never conceived a vigorous thought. The fact that the results of scientific men can usually be checked by observation and experiment, perhaps diminishes their liability to err and enables them to discover multitudes of errors that would otherwise escape their attention. This does not tend to make the results of their investigations less weighty than results which have been reached by other processes, more purely mental. If men of science, with their severe methods of research, their habits of testing their conclusions by observation and experiment, are nevertheless led into wrong conclusions, what does it prove? Simply that the human mind, even under the most favorable circumstances, is fallible! Is there a class of men less liable to make mistakes? It is precisely this experience which causes many to place a small value upon the unsupported assertions and speculations of any man, however honest, earnest, or able he may be.

On this point, one of the most admirable of experimenters, Faraday, has beautifully said: "The world little knows how many of the thoughts and theories which have passed through the mind of the scientific investigator, have been crushed in silence and secrecy by his own severe criticism and adverse examination; that in the most successful instances, not a tenth of the suggestions, the hopes, the wishes, the preliminary conclusions, have been realized."

In the 24th series of his "Experimental Researches," Faraday describes many tedious and intricate experiments, in which he tried to connect gravitation and electricity. "He labored with characteristic energy for days, on the clock tower of the Houses of Parliament and in the shot-tower of Southwark, raising

* Jevons, in Phil. Mag. Dec. 1861.

and lowering heavy weights, connected with wire coils. Many times his great skill as an experimenter prevented him from being deceived by results which others would have regarded as conclusive proofs of his idea, and when the whole was done, there remained absolutely no result." For although the results were wholly negative, Faraday could never accept them as conclusive against his idea, to which he had been led by his experiments on the relations between electricity and magnetism. His mental condition after this work was done, is best described in his own words. "Occasionally, and frequently, the exercise of the judgment ought to end in *absolute reservation*. It may be very distasteful, and great fatigue to suspend a conclusion; but as we are not infallible, so we ought to be cautious."

It is a matter of common observation, that men who, like Faraday, have done much to widen the boundaries of our knowledge, are precisely the ones who are most frequently in a state of doubt, while those who have received all their knowledge at second hand are generally more ready, with a positive decision and a reason for it, not necessarily because their intellectual integrity is less, but because they *cannot* realize how vain a thing the human reason is. To imagination and reason, controlled and checked by experiment and observation, are we to look as the source of the greatest advancement in science; but we are not to look for infallibility, and in cases where the reason alone is allowed to decide, where observation and experiment are impossible, the uncertainty must necessarily be greater. In many cases the fact that the subject is so intrinsically difficult that no experimental check is possible, appears to inspire the investigator with a confidence in his conclusions, that could hardly be reinforced by absolute certainty.

But we have not yet exhausted the list of errors to which scientific men are liable, in arriving at what we provisionally call correct conceptions of physical law. A few of them have carried their investigations into a domain in which certain hypothetical beings called "spirits" are said to be the main actors. It is exceedingly probable that a few trained investigators have been deceived in regard to the evidence of their own senses. This is not an unlooked for result, as it can be readily reproduced in the performances of any expert juggler.

I have confined myself to the errors which scientific men have committed, and to which they are liable in their search for truth, not because they alone are liable to err, but because a discussion of the multitude of errors into which intellectual men of other professions have fallen, would be sure to give offense. But it is not the scientific mind which stands impeached—it is the *human* mind!

To what end have we then come? It appears that all scientific results are attended with some uncertainty. Sometimes the uncertainty is very small, and we are able to obtain a numerical estimate of it. In other cases it may be possible that a fundamental misconception of the truth may have been formed. As an instance illustrating what I mean, we may cite the case of the measurement of the Atlanta base-line by the engineers of the United States Coast Survey. The whole length of the base-line was nearly six miles, and three determinations of its length showed differences of about 3-10 of an inch—about a millionth of the entire

length. It is safe to say that if these re-measurements had shown differences of ten feet, there would have been no quarreling in regard to which measurement was right, but all would have been rejected, and if the engineers were not dismissed as incompetent, they would, with feelings of mortification, have begun their work over again. It is curious to observe that in many cases where less skillful men attack problems infinitely more complex, reaching conclusions differing as widely as the poles, we have, instead of conscientious re-investigation or a modest reservation of judgment, dogmatic discussions, empty words.

In the other case, where the error is likely to be a fundamental one, the probability of the truth or error of a conclusion cannot always be determined numerically, and will vary greatly in different minds. For instance, A may think he saw a ball dropped into a box, and may feel certain that it is yet there; B is certain that it was a juggler's trick, and that the box is empty; C did not see the act, and has no opinion in the matter. About the *fact* there is no uncertainty: the ball is either in the box or not. No discussion can affect the matter in the least. The uncertainty is purely a mental affair, its degree depending upon the ability of the observers, their opportunities for investigation, and their previous training. Their differences on this subject will be wholly obliterated by an exposure of the interior of the box, and without the necessity for any discussion whatever. If the box *cannot* be opened, the matter will remain a legitimate subject for dispute. The fact that competent men think a subject worthy of dispute seems to me a good indication that the matter is, humanly speaking, uncertain. That unpleasant thing called intolerance, in those cases in which it is accompanied with sincerity, arises from an inability to see these points, and hence we have A making strenuous efforts to convert B and C to his own opinion, failing in which, he proceeds to burn them, to imprison them, to lampoon them in the newspapers, or to do some of the more quiet, but scarcely less effective things, characteristic of our own times, that the spirit of the age will permit. Perhaps no blame is to be attached to such acts. If they are failings, they are simply to be counted in with the other failings to which well meaning men are liable, and when the evil effects fall heavily upon us, it is perhaps wise to endure them with philosophic calmness, along with the other misfortunes which for some reason or other seem incident to human life.

In conclusion, allow me to say, that it seems quite probable that human welfare does not require us to sit in judgment on the ideas of others. Thoughtful men are becoming more and more impressed with the vastness of the unknown, and the comparative insignificance of human achievement, while the demonstrated fallibility of human reason leads them to temperance and modesty of thought and expression; to *appreciation*, as well as toleration, of opposition and doubt. Certain it is, that if we preserve our intellectual integrity, we shall be unable to settle many of the problems that interest us most. If we decide upon some of them, and other persons still reserve their judgment or decide differently, we need not lose our tempers; they have not only decided differently from us, but we have also decided differently from them. It is important to notice that neither of

these decisions has affected the *truth* in the least. If we feel called upon to defend the truth, we are, after all, only defending what we *believe* to be truth, and possibly against men as honest and as able as ourselves. But why should we defend the truth? So long as the heart of humanity shall pulsate, will not truth be cherished there? Why would it not be far better for each one to put himself in the attitude of a reverent *searcher* for truth? remembering always, that the little decisions that we may reach are possibly wrong, that all of the honesty and ability in the world is not concentrated within ourselves, and the comparatively few who think as we do, and that one can do nothing nobler, than to make himself as intelligent and humane as possible, resolutely following out his highest convictions, and living at peace with himself, and with all men.

PHILOSOPHY.

FOOTPRINTS OF PRIMITIVE THOUGHT.

BY JUDGE E. P. WEST, KANSAS CITY.

None of us, perhaps, realize how deeply crystallized in our boasted enlightenment of the nineteenth century are the footprints of primitive thought. We, notwithstanding the growth of human reason has removed some of the shackles which for long ages bound mankind in error, seem utterly incapable of taking in the full scope and consequences of our freedom, but linger amid the scenes of our former enslavement, fearful, or perhaps incapable, of leaving the chains when broken, which have so long bound us in error. As an infant with fear and mistrust essays its first step, which is the promise of its coming manhood, so we seem fearful of following the guidance of our reason—that grandest effort of the mind—the earnest of our coming intellectual manhood, directed by the ineffaceable pathway of truth—sublime, eternal, immutable truth!—evolved from necessity.

We have ceased to use the boomerang, the bow, and the stone spear and ax, but the ideas which originated with them in the infancy of the race, and which are as primitive as the boomerang and the stone spear and axe, have flowed down to us in an unbroken stream from primitive time, and are to-day intermingling with, and forming strong currents, urged by the impetus of past forces, to mar the harmony and placidity of the great ocean of human intelligence. I allude to ideas which, though deeply rooted in our civilization, never could have originated with a race having reached our present degree of intelligence, however limited, comparatively, that intelligence may be. But, we must not infer that all we have inherited from the past is untrue, for conceptions as true as those we entertain to-day have lingered with mankind for long ages.

To comprehend this clearly, we must consider man as he was in the primitive

times as compared with his present condition, and measure the varied stages of his development. And, at the very threshold of the subject, we are met with one prominent idea of almost universal acceptance, which has survived the very limited, or, perhaps, more properly, the very primitive intelligence that could have originated it; I allude to the wide spread error that man was created perfect, but degenerated in his physical and moral nature after his supposed creation upon the earth. Such an idea could not have originated with a race of our present knowledge, predicated upon known facts connected with man's past history, but, having originated in the race's infancy, it has been handed down by tradition, supported by superstition, from generation to generation, until it has become crystallized in our civilization and remains with us without a right exercise of reason, or, perhaps against our reason, supported alone by the glamour of the imaginary mysteries of the very remote past.

It has been less than four thousand years, but a brief moment compared with the great cycles of time in the world's history, since man attained sufficient intelligence to keep a meager written record of the events transpiring around him, and to record his own history. All prior to that time, for long unknown ages after man became man upon the earth, was the mere mythical traditions of an infant race, ignorant alike of their own being and of the workings of the natural forces around them; and whatever written record purports to give a history of man prior to the historic time may be regarded with great mistrust—as simply a synopsis of some of the traditions of a primitive people, recorded in an age just emerging into the historic time, and by historians whose knowledge of natural laws was very little superior to the people whose traditions they attempted to record. The only merit such a record can claim is, that it proceeds from the depths of the past and stands out a conspicuous monument of the errors of infant thought.

We must turn from the traditions of the living to the more trustworthy traditions of the dead, as presented in the vestiges left by man in the past ages, for a true picture of his primitive condition. Everywhere on the earth's crust where civilization holds a footing, there are to be found in the natural caverns and in the tumuli erected by man, vestiges of his former existence, extending back, probably, to the miocene time. During all those long ages, embracing many thousands of years, man can be traced, and the more remote the tracing the less perfect in physical structure and in intelligence we find him to have been. He was incapable, probably, in the very early infancy of the race, of fashioning the very rudest implements for his convenience and defense. He was incapable of clothing himself, for he knew nothing of the manufacture and use of clothing. He was incapable of erecting an artificial structure for a dwelling place, but used the caverns and grottoes which nature had fashioned, for shelter and protection. He knew nothing of the use of fire for warmth or the preparation of his food, but he ate his food raw. He had but little idea of a fixed abode, or of laying up for a rainy day, but gathered a precarious subsistence from the stores of nature around him. In his early struggles for existence, he used only those implements which

nature had fashioned to his hand. Such was the condition of man as traced by the remains he has left all along down the varied stages of his past career. From his primitive condition he emerged slowly, and his advancement is well marked in an unbroken sequence from the palæolithic or rough stone age, in which man began to fashion rough stone implements for his use in war and the chase, to the neolithic or polished stone age, in which he acquired the art of polishing his implements, through the bronze age, in which he acquired the use of metals, down to our present comparatively high place in the still cumulative iron age.

During all these long ages in which man has filled his place in the world's evolution his tendency from a lower to a higher development has been unbroken, very slow at first, indeed in all ages, but with accelerated growth in proportion as his development became more perfect and capable of a wider range of comprehension Who that has studied the tangible vestiges associated with man in the past, can believe for a moment that he has been superior at any former time to what he is in our own generation; if he had been so some token of his superiority would have been left behind him as evidence of his merit. Who can doubt that thousands, nay perhaps millions of years hence, vestiges of our present civilization will not afford unerring evidence of our great superiority over the past generation of man. It is necessary to have a clear conception of man's gradual advancement in order to comprehend more fully many of the ideas which have drifted to us from the past, and still linger with us in our civilization, and exert a marked influence in our mode of thought, and in shaping our conduct. In this connection I may allude to a prominent idea which assumed form comparatively recently in the Abraic branch of the Shemitic race, but which had its germ far back in the primitive time; I allude to the wide spread error which we find ramified in the teachings of all the Abraic and Christian races, and which, though not now believed by the more intelligent, yet retains a firm footing, and is used, not only by the descendants of Abraham and all Christian nations, but by some very intelligent societies, as a date of the world's beginning; I allude to the date, namely, 5639, according to the Jewish reckoning, used to express the world's age. It is unnecessary for me to call the attention of this intelligent audience to the manifest error of this date as presenting either a correct idea of the world's age or of man's duration upon it.

The progression of human intelligence to which I have alluded, has not been accidental or uncertain, but has moved in well defined lines which indicate clearly beyond the boundary of a reasonable doubt, the gradual unfolding and growth of the human intellect, from a very low order to our comparative high degree of development. But, while the general tendency has been steady, there have been intervals of retarded or accelerated advancement. The growth has been, too, in strict conformity with the natural laws of evolution, that is, in those channels which a people would naturally follow, emerging from a lower and passing to a higher order of development.

We may divide this development into five different channels or classes, as represented by ideas, each of which is capable of a further subdivision. namely:

1. Ideas flowing in channels in which the appearance is consonant with, i. e., represents truly the object observed.

2. Ideas of utility, which suggest the fashioning of natural objects for man's practical use.

3. Ideas growing out of, or suggested by the social relations of man with man in aggregate communities.

4. Ideas flowing in channels in which appearance is not consonant with, i. e., does not represent truly the object observed, and

5. Ideas associated with the imagination and emotions, and in this connection, ideas crystallized from tradition.

In the first class may be prominently considered the æsthetic effort of the human genius to reproduce in picture things esteemed of interest, as man, animals, plants, rivers, lakes, mountains, and objects in which the true idea of form, position, &c., is conveyed by the outline of the object. This was among the first of the distinctive efforts of the human genius in a well marked and permanent line of development. Indeed, we find in a much lower order than man, as in some animals and birds, the æsthetic taste strongly marked, but we have no evidence of their advancement, while in man, evidence of progression is marked in every stage of his past history. Among the earliest remains left by primitive man, and associated with the rudest stone implements fashioned by him, are to be found rude efforts at picturing the natural objects around him. This effort, from its rude beginning, as illustrated in its attempt to reproduce in picture the living mastodon, gradually advanced until art had attained a comparatively high place among the ancient Egyptians and Phœnicians of the East, and the Peruvians, in the time of the Incas, of the West, and, until it culminated finally, in a perfection among the Greeks and Romans, more than two thousand years ago, which has not been surpassed in our own time. We may safely assume that the wavy lines of female beauty have never been reproduced with greater perfection than among the ancient Greeks, and we yet borrow with profit from ancient art.

In the second class, may be included a long array of objects useful to man in his various needs in the ordinary walks of life; prominent among which may be named architecture, road making, bridge building, bronze casting, the culinary art, and the construction of textile fabrics. In those useful branches, in which the technical skill employed is of a low order, many of the ancient nations, as the Egyptians, the Chaldeans, Assyrians, Hindoos, Chinese and Peruvians, had, very remotely, made great proficiency, and later, the ancient Greeks and Romans attained a degree of perfection which we may yet, in many respects, copy with profit—a progression by no means unworthy our admiration, when we consider that the first effort at the useful arts consisted, probably, in simply the breaking off the rough corners of a stone to be hurled by the hand in the chase, in war's aggression, or in personal defense against enemies.

As to the third class, whatever differences of opinion there may be as to the causes which lead to man's tendency to aggregate in social communities, it is well known, that from time very remote, his individuality, to a limited extent, has

been merged in the social and political compact, in the relation of tribal, or state government. Aggregation, very soon, suggested the necessity of rules for the government of the aggregated communities, and, rules growing out of usage, improved upon by experience, from generation to generation, finally, after long ages, ripened into maxims for the moral and political government of the people among the most advanced nations, as the Chaldeans, Phœnicians, Egyptians, Chinese, Hindoos, and Jews. And, while the maxims among the advanced nations were not entirely the same, they did not very essentially differ. Among the maxims thus crystallized from usage and experience, which stand most conspicuous in the moral and civil codes of the enlightened and civilized nations, may be reckoned those contained in the Decalogue, the Vedas, and the maxims of Confucius and Laotse.

It will be perceived, that in the three classes which I have considered, that no great technical or scientific skill was required, but the advancement flowed naturally, either from the suggestion of the æsthetic tastes, or from the suggestions of convenience, utility, or necessity, and the advancement made, however great, is little more than improvement from long usage by accumulated experience; and, it need not be a matter of surprise if a proficiency was made two thousand years ago which we have scarcely surpassed in our own time.

The maxims of the Roman law enter largely into the jurisprudence of the civilization of Europe and America, while those of Confucius, and Buddha enter largely into the Mongolian and Indian civilization. So, too, with architecture, sculpture and painting, our civilization derives its ideas in those arts from the ancient Greeks and Romans, while the Chinese and Indian races have scarcely improved on the proficiency they had made two thousand years ago. But, there is one very suggestive and important fact we must not overlook, namely, that infinitely greater advancement has been made, in these branches, in the last five thousand years, than had been previously made in all man's duration of, perhaps, more than a million of years, upon the earth; showing how very slowly the human intellect has emerged from its infancy, and with what accelerated force it has moved, as it has acquired strength. In sculpture and painting, we have made no recent advancement, and the only improvement made in the branches I have considered, in the past two thousand years, has been in government, in architecture, and the domestic arts. In the latter, including architecture, our only improvement has been in practical utility. In this, the advancement in the last century has been very marked. The finely finished, symmetrical and practical domestic implements of to-day, exceed, infinitely, their prototypes of the olden time; as do also our dwellings, in practical convenience and comfort; but, we have simply improved, in this respect, upon ideas which prevailed more than two thousand years ago. In government, our improvement, though marked, is more in promise than in present achievement; I allude to the tendency, by intellectual development, to the equality of all men, intellectually, and in social and political rights. Such equality may be considered visionary, and surely would be, in our present degree of intellectual development, for, so long as we are short of

truth, and are advancing toward it, some will be in advance of others in the race, but, once attained by all, as it surely will be, in the great evolution of time, all that the mind is capable of grasping will have been grasped, and equality, where all have attained the same intellectual plane, will necessarily follow.

But, long before this attainment, the great tendency now going on, in the civilized world, toward exact legal justice and equality, growing out of the increased intelligence and self-reliance of the great masses, will have been achieved by a universal practical recognition of these great principles of right. The legal and social distinctions which prevailed in the past, and which we yet inherit, to a limited degree, from our primitive ancestors, will have passed entirely away, and universal toleration of opinion and perfect social and political equality, will be recognized, for the intelligence of the great mass of mankind will have reached a plane intellectually high enough to demand it. The advance we have made in government, is toward the recognition of the equality of all men.

In the fourth class, namely: ideas flowing in channels in which appearance is not consonant with, i. e., does not represent, truly, the object observed, may be included the whole field of chemistry and astronomy, as applied to the visible universe. It is in this vast field, extending from the lowest molecule of matter, to the largest aggregate body, that the human mind is most at fault, and still inherits, most strongly, the errors of primitive time. This is not to be wondered at, when we consider that chemistry has had a true scientific growth of but little more than two centuries, while astronomy, as a science, can claim little more than three hundred years since the genius of Copernicus, wandering out of the mere appearance of things, grasped, and the genius of Gallileo afterward demonstrated, a true conception of the form and movements of the bodies composing our solar system.

Most prominent among the errors of this class, and which have left a deep impression on the entire human race in all ages, is the idea of fixity in the visible universe, and the idea that all material things had a definite beginning—a literal creation from nothing—and will suffer, at some future time, utter annihilation. These ideas could not have originated with a people of our present knowledge of the natural laws governing the grand universe of matter, but, being deeply rooted in the primitive mind, they have passed, by inheritance, to our own generation, and still cling to the great mass of mankind, with a pertinacity which the most intelligent have scarcely escaped from. They, too, are the groundwork of most of the errors which have descended to us from our primitive ancestors, and which still obscure and retard a true conception of our place in the great evolution of time.

Man's first impressions, after he became capable of definite ideas of the visible universe, were in harmony with the mere appearance of things, consequently, each individual supposed the world to be flat, and himself in the center of a vast plane, around which the sun and moon, and innumerable small, insignificant stars, made for ornament, were destined to revolve, at a distance of a few hundred miles at most, above the observer. Oceans, lakes, rivers, mountains, rocks,

earth, all were supposed to be made, and located definitely, as seen. Animals and plants were supposed to have been reproduced, without variability, from the creation, to the time of the beholder. I may venture to say, we have not now, in our common schools, a boy ten years old, who does not know that these impressions are wrong, although they prevailed, almost universally, to within two short centuries ago, and still prevailed very largely, among the masses, within the last half century, and, I may add, are entertained by some of to-day, among the most enlightened nations of the world. We have overcome some of the simpler of the errors of our ancestors, and have somewhat enlarged our intellectual prison bounds, but, we are yet far short of perfect freedom, for the most intelligent seem yet limited by the idea that the present phase of the solar system was the ultimate aim of its creation. It matters not whether the belief is that creation was accomplished in six days, or in six long geological ages, the idea of a definite beginning, from nothing, and ultimate annihilation is, all the same, fixed and well defined. The introduction of matter is considered a kind of short interlude between infinite time, preceding its introduction, and infinite time which is to follow its destruction. The interlude, according to the generally received opinion, was for man's introduction upon the stage, but, it would seem, he egregiously failed in his part in the great drama. The outside unlimited expanse of worlds was scarcely taken into the account at all, but was considered a kind of decoration for the earth, or, at most, for the solar system; and the idea of their real entity, now that their true character is known, is little less vague and unreal. We have somewhat enlarged the boundary of our knowledge, but it must be confessed that these ideas have as little foundation in fact, and are as crude in respect to the real entity of the visible univer e, as some of those we have discarded.

We have no right to assume that matter can be annihilated, for the universal experience of mankind is, that, while it is capable of almost infinite change, it cannot be destroyed. If matter is, and is incapable of destruction, we have a right to assume that it has always had a being, and will continue forever to be—that matter is Infinite! If we assume the infinity of matter, as we may do, if we assume its being, and indestructibility, and, if we further assume that the matter of the solar system, at some time in the past, entered upon its present phase, and, that the present phase will terminate some time in the future, we have a right to assume its capability of entering upon, and passing through, other similar phases —that it may have done so in time precedent, and may do so again in time to come.

The creationists have a well defined belief, that for infinite time, preceding the introduction of the matter of our world, and for infinite time which is to follow its annihilation, nothing material existed, or will exist; that in its present phase, matter had its definite beginning, and will have its definite annihilation and ending. He looks upon material things as a brief tempest of discordant energy, introduced in the lull of infinite time and reign of pure intelligence.

In contrast with these vague, unreal ideas, coming to us from the past, we now know that the stars, filling the outside depths of infinite space, as far as we are

are capable of scanning them with the highest magnifying power known to us, are real suns, composed as our own sun, and many of them exceeding him many fold in magnitude and energy; and we have a right to assume that they are centers of other systems of worlds, not very materially unlike ours, governed by the same laws, and the same destiny.

Admitting the nebular hypothesis to be true, and nothing accounts so well for all the phenomena attending the solar system, we must infer that all the heat now stored in the laboratories of the sun and his attendant planets, and their satellites, will ultimately be dissipated by radiation, and all the bodies composing the system, become dead matter, destitute of light, heat, and every kind of energy, save the ever persistent force of gravity, and their diminished orbital motions. The darkness of night will prevail, and without a sound to disturb the awful stillness, which will pervade the mighty depths of our system, the bodies composing it will move in silence and darkness, drawn by the relentless force of gravity, to a catastrophe the most stupendous that our worlds are capable of—a catastrophe no less than the change of the entire dead, inert matter of our system to a living energy. Suppose the repulsive force of heat entirely exhausted in our solar system, and the unresisted force of gravity continuing to work, we may assume that the bodies comprising it would be drawn together by one of two methods, namely, by a sudden, direct and violent concussion, or by a gradual approach, maintaining their orbital motions, until they became united in one body The consequences following either mode of union can hardly be doubtful. If hurled suddenly and violently together, at a velocity which would necessarily obtain by such mode of union, the impact would generate heat enough to throw off the entire mass in a gaseous condition; if, on the contrary, the approach to a union in one body was gradual, the pressure incident upon unresisted attraction, would be so great as to generate a heat capable of converting all into a gaseous state. Unresisted pressure, or violent concussion, either, is capable of converting matter, which has satisfied its chemical energy, into new activity, or, more correctly, into new molecular vibration. Shall we assume that the matter of the solar system, after this short phase of its existence, will be annihilated, or, that, after exhausting its energy, will assume a passive state, in which it will continue forever, or, that its present condition of energy has continued for infinite time in the past, and will continue for infinite time to come. Neither of these assumptions is tenable, while the idea of renewed energy, or the transfer of energy from aggregation to limited expansion, is in harmony with all the phenomena of the solar system and with all the facts which we have drawn from the starry depths beyond. It has been the grand privilege of this generation, to witness the transfer of energy from aggregation to expansion, in the domain of a distant sun. On the evening of the 24th of November, 1876, in the constellation Cygnus, there suddenly burst out from the darkness of night, a flame of light—a new nebula, the incipient energy—renewed from the ultimate limit of aggregation—which is to form, in the great cycle of time, new worlds and a new sun, destined to play their ever varying parts in the great drama of renewed life. In drawing a com-

parison between a new star, which appeared in the year 1866, in the Northern Crown, and the new star I have alluded to, in the constellation Cygnus, Prof. Proctor, of the Royal Observatory of London, says: "Let it also be noticed, that the changes which had been observed thus far, were altogether unlike those which had been observed in the case of the star of the Northern Crown, and, therefore, cannot justly be regarded as pointing to the same explanation. As the star in the Crown faded from view, the bright lines, indicative of glowing hydrogen, died out, and only the ordinary stellar spectrum remained. In the case of the star in the Swan, the part of the spectrum, corresponding to stellar light, faded gradually from view, and bright lines, only, were left, at least as conspicuous parts of the star's spectrum. So that, whereas, one star seemed to have faded into a faint star, the other seemed fading out into nebulæ—not merely passing into such a condition as to shine with light indicative of gaseity, but actually so changing as to shine with light of the very tints (or more strictly, of the very wave lengths) observed in all the gaseous nebulæ." But, the eventful history of this new star did not end here, but it still continues to shine with true nebular light.

In contrast with the vague notions which we still cherish, and adhere to, as inherited from the past, we may assume the universe of matter to be infinite, and capable of infinite change. We may assume that our own solar system is but one of innumerable systems filling universal space, and liable to the same destiny. We may assume that the bodies, or matter composing the various systems of the universe, are in every stage of development, or more properly, molecular activity, all the way from dead worlds, groping in profound darkness and silence, to the highest degree of molecular energy—that, like the fabled Phœnix, worlds, and systems of worlds, spring into new life and energy, from the ashes of their own ruin.

I must invite your attention to another important fact, before closing this branch of the subject, namely, that while the growth of the human intellect has been slow and gradual, as directed and advanced by usage and accumulated experience, in the first three branches I have considered, the approach to true conceptions of the form and motion of the heavenly bodies, and their chemical combinations, was presented suddenly to the human comprehension, through the genius of a Mayer, a Copernicus and a Galileo, after the intellect had attained sufficient growth to grasp and weigh abstract ideas by true scientific methods.

I have consumed so much of your time, with all the brevity I could use, in treating the former branches of my subject, that I shall have to be very brief in considering the last division, namely: Ideas associated with the imagination and emotions, and ideas crystallized from tradition. The imagination has been, in all ages, a fruitful source of brain conception, and of giving form and color to the ideas conceived. It may be regarded as a pilot which invites the following of the more prosaic verification of the truths which science unfolds in nature. Its following is often deceptive, and, sometimes, after long voyages of pleasing delusion, leads to the utter wreck and ruin of long cherished opinions; but, it must

not be discarded because it has sometimes led to rocks and quicksands, which have wrecked the voyager, for, notwithstanding its some-time delusions, it has often led into safe harbors of scientific verification and truth. It has preceded some of the most important of our scientific discoveries, and is closely allied with human progression. It has anticipated the greatest pleasures, and pictured the wildest horrors. It revels in the most trivial affairs of life, and goes boldly out, in defiance of time and space, and all material things, to people unknown realms with ethereal beings. Aided by the emotions, it has given to airy nothings a "habitation and a name." It has located for the American aborigines, a happy hunting ground, where the shade of the departed warrior enjoys an eternity of bliss, basking in the smiles of the Great Spirit. It has, for centuries, kept the watchfires burning among the Aztec races, awaiting the return of a Montezuma. It has erected a seventh heaven for the eternal repose of the true Mahommedan believer. It has filled the surrounding air with the spirits of the departed ancestors of the Chinaman, to exercise a malign or good influence over the destinies of the living. It has located habitations of never-ending, and unchanging, states of bliss, and has fixed prison domains of perpetual torture, from which escape is hopeless. It has created, and individualized, supernatural beings, in the realms beyond, possessing every degree of power, and endowed with every shade of malign or good influence over the destinies of men. It has limited, in the early stages of its development, the great universe of matter to our own world, and made it the grand central figure of all material things, and man as the crowning work and aim of its conception. These ideas, short as they are of the real grandeur of infinite nature, have become concrete from tradition, handed down in the remote past, from generation to generation, among various nations and tribes according to their respective beliefs. But the wildest stretch of the imagination is far short of the grand reality in nature,

> Which, ocean after ocean of different density unfolds,
> To form in all nature, and infinity, "one stupendous whole."

ON SCIENCE AND MAN, WITH SPECIAL REFERENCE TO PROF. TYNDALL'S LATE ADDRESS.*

BY REV. NOAH PORTER, D. D., PRESIDENT OF YALE COLLEGE.

We observe, before the argument of Prof. Tyndall begins, a little skirmishing. In speaking of the dependence of the individual upon the forces of the past, Prof. Tyndall says that Boyle regarded the universe as a machine, but Mr. Carlyle prefers to regard it as a tree, and adds: "A machine may be defined as an organism with life and direction outside; a tree may be defined as an organism with life and direction within. I close with the conception of Carlyle. The order and energy of the universe I hold to be inherent and not imposed from

*Read before the Victoria Institute in London.

without—the expression of fixed law and not of arbitrary will." In speaking thus he forgets that to a great majority of scientists the very conception of an organism implies external intelligence, and his confusion of mechanical with organic relations becomes apparent in his further remark that "the interdependence (of the sciences) of our day has become quantitative—expressible by numbers—leading directly into that inexplorable reign of law which so many gentle people regard with dread." In his subsequent argument every position is chosen in such a way as to induce the conclusion that the universe of matter and spirit, including the phenomena of moral conviction and feeling, as also of religious emotion and faith, is wholly subject to no other than mechanical laws. At this point the argument proper begins; hitherto all has been but preparation. He now traces and illustrates the doctrine of the correlation of physical forces. He considers next the analagous interchange of decomposition and combustion in the use of the galvanic battery for chemical results—illustrating the truth that chemical elements which are united in combustion at one point in the circuit are liberated in exact equivalents at the other. Having taken two steps in his argument, he essays a third, and suggests that the same process under similar laws may go on in the body of man. Having demonstrated that heat is interchangeable with mechanical energy in mathematical equivalents, and that combustion involving heat is in like manner interchangeable with chemical decompositions, he abruptly asks: "Is the animal body then to be classed among machines?" The friction wheel of the galvanic battery only distributes force—transferring it from one point to another, and varying its manifestations to the senses—but never creating it. Does the animal do anything more? "When I lift a weight, or throw a stone, or climb a mountain, or wrestle with my comrade, am I not conscious of actually creating and expending force?" The ingenuity of thus putting his case is altogether admirable. The man who asserts that the body only transfers force must own that it is a machine; the man who denies that it is a machine must hold that it can of itself generate—*i. e.*, originate—muscular force. The merest tyro in logic would be wary enough to say: I am not prepared to say that A is either B or C, for it may possibly be either B, C, or C plus D. That is, the human body may be something else than either a generator or a transmuter of force—it may perhaps perform other offices than a friction wheel or a galvanic battery. Prof. Tyndall having shaped his major premise to suit himself, proceeds to discuss the minor premise by asking whether the human body generates mechanical force. He answers his own questions by an elaborate and varied series of illustrations, all of which are designed to show that mechanical force and heat and chemism are related to one another in the human body precisely as in the friction wheel or galvanic battery, and that the body falls into the category of machines. This may all be true so far as the production of muscular power is concerned. But within the body other work is done that, according to Tyndall and Mayer and all the scientific world, is a special function accorded to the nerves—over and above any which the correlation of forces can illustrate under mechanical law in the machine or chemical decomposition in

the battery—and this is a function of directing, *i. e.*, of liberating and detaining muscular force—which is illustrated by lifting a valve or pulling a trigger. It were well illustrated by the power of a band to carry motion in a machine or of wire to transfer potential motion or potential heat in a battery. It is very evident that when Prof. Tyndall began his argument, which was to prove that "the body falls under the category of machines," and that as a machine it generates no force, he thought of no other function as possible except the two—of generating or transforming force. Now seeing that his body does through the nerves perform the additional function of directing or transferring force, of determining when and where it should act, he meets this indefinitely conceived demand by the convenient image or picture of a valve, a detent in a machine or a trigger in a musket.

He ought to have bethought himself and corrected the premises of his disjunctive, and, instead of asserting the animal body either creates force or transforms force, he should have said the human body either creates force or transforms force or also directs force. Then, in order to prove that it is a machine, he must prove that it directs force through the nerves by either mechanical or chemical agency. This last he does not attempt to do. He does, indeed, assume that nerve substance is wasted by use, and implies that heat is probably evolved in nerve activity, but in all this there is not the slightest attempt to explain by what mechanical process the nerves direct or transfer motion. The body is accepted as a finished machine, now ready for the "kindling of consciousness," which may turn out to be a form of heat evolved by mechanical laws. Under this notion he marches boldly up to the new line of inquiry which relates to the connection between this machine and a highly poetic or idealized force, sometimes called the soul. In this examination he is far from successful; for the question is not whether the body, so far as it is material, is subject to material laws, but whether it is not also a living body, and what forces, relations and laws this conception implies.

What is most surprising is, not that a certain class of scientific men do not see this distinction, but that so many insist in one breath that no scientific theory can be accepted which is incapable of mathematical formulation and experimental verification, and in the next breath adopt a theory of life on a mechanical and chemical basis, the laws of which they do not profess to have formulated in numbers nor to have tested the alleged facts by experiment. Prof. Tyndall insists that "the interdependence of our day has become quantitative—expressible by numbers," and that where law cannot be formulated by numbers there is no science. We insist that if under this definition psychology, morals and theology are excluded from the domain of science, physiology should be excluded also, and yet the whole doctrine of development, with heredity and its variations and integrations, and all the nomenclature by which the soul is demonstrated to be but a higher potency of matter, and personality to be an ideal fiction, and God an entirely superfluous hypothesis—is derived from the very

operations of life, scarcely a single one of which if tried by the criterion in question has been scientifically fixed or formulated.

But where do the supposed relations between the machine-body and the soul begin? Prof. Tyndall, speaking of the case of a man who receives bad news in a letter, and springs up and hastens to save his fortune from wreck, says that the whole of the emotional, intellectual and mechanical action of the body was caused by the impact upon the retina of the infinitesimal waves of light coming from a few pencil marks on a bit of paper. He assumes that terror, hope and all the emotions through which the man goes are caused by the impact of the undulating light upon the responsive retina; that this imparts another impact to a somewhat ceasing terror, which in its turn by another stroke or impact is transformed into hope, till at last the latch is lifted, the muscular power is set free and the man springs to his feet. This assumption concerning all these processes resolves them into mechanism and subjects them to the law of necessity. It takes for granted that whatever the soul may be, its phenomena are caused at first by the impact of a material object and follow in succession according to mechanical necessity. The proper attitude to assume is that of protest against every such assumption. The true and wary philosopher will say just at this point: I do not accept your version of these intervening phenomena; they are in no sense evoked by the object striking upon the man, but they are performed by the man with reference to the object. It is not the letter which strikes its impacts upon the man, but it is the man who reads the letter and thereafter acts in calculation and hope until the latch is lifted and the muscular motion is set free. We know that this view is very strange to Prof. Tyndall's method of philosophizing and is fatal to all his conclusions, but in our view it is true to the facts, and we must protest against this stealthy, even if it be an unconscious, way of discussing the facts by the mode of asking the question, whence the impulse and how did it originate, that directs or liberates motion in the various methods so vividly described? This is indeed the critical question. It is none other than whether there is any other agent than matter, and whether the agent, be it material or aught besides, acts according to mechanical laws and under mechanical necessity. How does Professor Tyndall answer this question? He remarks first of all, "The aim and effort of science is to explain the unknown in terms of the known. Explanation, therefore is conditioned by knowledge." This truth he proceeds to illustrate by the story of a German peasant, who, when he saw a locomotive for the first time, having never known any other than animal power, after long reflection solemnly said: "There are horses inside!" The story in Prof. Tyndall's opinion illustrates a deep-lying truth. It strikes us that the deep lying truth which Prof. Tyndall finds in it admits of an application to himself. Had the peasant known no other locomotive power than that by horses he had reasoned wisely, provided the peculiarity of the effect was not fitted to awaken a suspicion that there were some things he did not know. When Prof. Tyndall insists that all the functions of the animal body are explainable by mechanical or galvanic agency, he seems to say, "There are horses inside. I know only of

motion, heat, breathing and eating, and these only are the forces I accept." Hope and terror are unknown qualities to science, and can neither explain other phenomena nor be explained, and the reason why we cannot unite them in a causal connection is that while we can form a coherent picture of physical processes we can form none of a molecule producing a state of consciousness acting on a molecule, and physical science offers no justification for either of these connections. Now, if by picturing the soul or the mind is intended that it cannot be pictured as occupying space and as affecting the bodily senses, i. e., cannot be imagined as material substance, this is true; but if it is contended that the mind cannot be pictured as the mind finds itself in its operations, then it is untrue, and that it is untrue is affirmed by Prof. Tyndall himself every time in this discourse he says I see, or know, or remember, or believe. If he means that he cannot picture the mind as acting, we reply that he can picture the acting of the mind as truly as he can picture the acting of the body. If he attempts to picture what he means by force, whether galvanic or mechanical, he will find this as difficult as when he attempts to picture mental force. If he cannot picture mind as acting upon matter, or matter acting on mind, no more can he picture matter acting on matter. If he says that he knows nothing about mind, and that therefore psychical existence and psychical action can not be used to explain any phenomena, because this would be to explain the unknown by that which is more unknown, he refutes himself every time that the words *to know* escape from his lips. And if we know nothing of the knowing process or knowing agent, what confidence can we have in what it knows of matter? To say that all this agent can know is matter is to beg the question, while in the very terms in which we beg it we assume that that function which we call knowledge gives law and authority to itself and the science which it creates. Prof. Tyndall's argument, carried into the domain of morals and psychology, results in his conclusion, that "following the lead of physical science, we are brought without solution of continuity into the presence of problems which, as usually classified, lie entirely outside the domain of physics. To these problems thoughtful and penetrating minds are now applying those methods of research which in physical science have proved their truth by their fruit. There is on all hands a growing repugnance to invoke the supernatural in accounting for the phenomena of human life and the thoughtful minds just referred to, finding no trace of evidence in favor of any other origin, are driven to seek in the interaction of social forces the genesis and development of man's moral nature." The careful reader will observe in these concluding words the affirmation for the first time in any of Prof. Tyndall's writings, of the tenet that moral distinctions are the product of social agencies. That he must of neessity hold this opinion was clearly enough to be seen by any one who follows the logic of Atheistic Evolutionism, to which Prof. Tyndall professes that he has been led with so many other thoughtful minds by scientific necessity. Thus has Prof. Tyndall been led to the following answers to the problems of mind and matter:

Negatively there is no spirit, no freedom, no God and no immortality, and

positively the scientific and practical explanation of the past and the promise of a future lie in a blind force working under the law of progress for man's amelioration, as the result of whose workings the idea of moral good is in due time developed, in whose name law is administered without justice. Morality as a social product creates religion, which rules by relentless force without personal sympathy.

The argument consists of four divisions. Of these divisions the first recapitulates the history and evidence of the conversation and correlation of force in the domain of physics. In this argument Prof. Tyndall is at home. His statements are clear, his examples are pertinent and the experiments are manifest. We will admit that the argument is decisive. The second division is that in which he agrees that the animal body is a machine, which is controlled by those forces and only those forces, and obeys those laws and only those laws, which are found in the inorganic sphere. This argument seems defective, in that it omits many of the phenomena which are most characteristic of the animal body, and transfers analogies from one physiological function to another, with an intellectual haste and audacity which are utterly foreign to the methods of physical science, or indeed of any science, whether pure or applied. The third division declares that all those phenomena called psychical should be treated by the scientific man as utterly unknown—as incapable themselves of being explained by any other than natural forces and laws, and of being stated in any other than figures of poetic ideality. This position he does not argue. He simply begs the conclusion, and not only this, but he dishonors science itself by this very assumption, because he dishonors the agent which is the Creator of science, and by his own sovereignty is the law-giver of science, imposing upon its own work the methods of procedure, and declaring the manifold services, Prof. Tyndall himself being witness, which theory, question, imagination and experiment have contributed towards its triumphs. Moreover, he asserts that the soul, though potent and sovereign in these creations, is nothing but an idealized abstraction. The fourth division consists of a rambling and somewhat incoherent argument, which we have endeavored to condense, upon the higher themes of man's responsibility to himself, his fellow-men and to God. In all this part of the discourse there is not the slightest suggestion of the methods of induction or experiment, such as are pursued in physical science. There is not a single example of those analogies which open to the sagacious interpretations of scientific genius, glimpses of a brilliant speculative theory. The four divisions of the argument are held together by the foregone conclusion that the devotee of science may recognize nothing in the universe, but matter, fate and evolution. In the first of these divisions Prof. Tyndall writes as a physicist, clearly and consistently. In the second as a physiologist, and here he is limited in his recognition of vital phenomena and committed to the foregone conclusion that life can be explained by mechanism. In the third, as a psychologist, he is a sturdy materialist in his reasonings and a poetical abstractionist in his concessions. In the fourth he is a moralist, metaphysician and a theologian, and as a moralist accepts the hard theory of Hobbes

as made flexible by Darwin and Spencer. As a metaphysician he is a fatalistic evolutionist with a dash of imaginative optimism, and as a theologian he is a sentimental atheist or an imaginative agnostic. In each of these several capacities he dexterously shifts from one phase to another, according to the varying needs and aspects of his argument. No man has insisted more strongly than he upon the necessity of mathematical formulization to fix whatever laws are surmised and of rigid experiment to test and confirm the most plausible generalizations. In this address he seems to have forgotten to exemplify the first article of his own philosophic creed, and to have wofully failed to apply the tests of experimental verification.

ARCHÆOLOGY.

THE ORIGIN OF METALLURGY—THE BRONZE AGE.

[*Continued.*]

We will now speak of the places where products of bronze industry were found. The first steps of science were difficult and uncertain, because discoveries were made by mere chance and by inexperienced men, who very often sold their antiquities by weight, and sometimes destroyed them even. Thus in 1859, on a farm of M. de Gourgue, near Bordeaux, "the husbandmen on returning from the fields, told their master that during the day they had found a corpse, that they tried to smash its head with their sabots, but it was so big and hard that they could succeed only with their spades." They brought back with them, however, a hatchet, a sword, golden threads and fragments of pottery. The following occurred in 1865 at the celebrated pre-historic foundry of Larnaud (Jura), "Brenot fils, while digging potatoes, discovered a piece of green metal which excited his curiosity and that of his friends. They set to work and found a quantity of objects of the same metal within a plot one meter square. The next day Brenot pere took a specimen to Lons-le-Saulnier, a brazier, who told him the bronze was worth forty cents a kilogramme. On this man's suggestion, Brenot offered his treasure-trove to an amateur of Antiquities, M. Z. Robert, who did not hesitate to take them. There were about eighteen hundred pieces, weighing 66½ kilogrammes." All this bronze came near being thrown into the crucible of the founder. It is now in the museum St. Germain, and is one of the most interesting collections. One more incident may be given. The ancient foundry of Vernaison (Rhone) was found in 1856 on the property of M. D——. The total weight of the bronze was 16 kilogrammes, but the director of the Lyons museum at that time, retained only a small portion. "We have selected," said he

"the complete, or mutilated objects most worthy, to adorn the museum, the rest was returned to M. D——, who proposes so have cast a commemorative urn, with an inscription recalling the event of the discovery." Notwithstanding the dangers by which the prehistoric science was surrounded, the bronzes in France and Savoy are already so numerous and so well characterized, that M. E. Chantre has been able to class them into categories which we divide into two groups: the *visible strata*, and the *hidden strata*. The first comprises grottoes, dolmens and palafittes or lacustrial habitations; the second, treasures, foundries, isolated stations and tombs in open fields.

It is well known that caves formed the first habitations of man, not only during the stone, but also the bronze age. Throughout Europe inhabited caves are found. The most interesting, perhaps, are those of Central France and on the banks of the Meuse. The latter have the advantage of being in three planes, representing three successive risings of the river which irrigated its banks. They present supposed layers of human remains of three consecutive epochs; that of metal, of polished stone, and of rough stone. The latter, which is beneath the other two, is no longer found on a level with the other two layers which were then beneath the water, for the Meuse at Dinant was not less than three leagues wid . Among the human remains there are bones of mammoths, hyenas, reindeer, animals which were then in France and Belgium. The inhabitants of the caves made earthen vases, but knew not the art of baking them, although they had fires. M. Dupont, (L'homme pendant l'age de la pierre) from whom the following is obtained, estimates that during the period of the mammoths, the width of the Meuse at Dinant decreased from 12 kilometers to 400 meters, which is the distance of the caves in the center. To day it is but thirty meters. The middle layers just beneath those of the mammoth, correspond to the period of the rein-deer, the grottoes, which are termed pits of the Mitons, of Chaleaux, of Frontal, are striking examples. The remains of human industry are buried beneath a bed of yellow clay which covers them. In these no bones of mammoths or hyenas are found, but only those of some species now living; the wolf, fox, deer, wild goat and rein-deer. There are not yet any polished stones; there is no trace of metals; the potteries are made by hand but are not baked; small stones, pieces of bone, teeth of animals, or fossil shells with holes, composed the ornaments of those people. The third layer, corresponding to the interior caverns on the borders of the Meuse, is that of polished stone; it is the epoch of dolmens and lacustrial cities of Switzerland, Savoy and Italy. Yellow clay disappears, the rein-deer, elk, wild bull, and castor have all disappeared. The hatchets are made of polished stones with holes for inserting handles; the potteries are now baked. This epoch has left behind but little remains in caverns, but much is found in the earth of the fields. It is here that bronze makes its first appearance, and though scarce in Belgium, is found in great quantities in Central Countries. The caves of the bronze age in France and Savoy are of two kinds, those used as dwellings and those, whether natural or artificial, for sepulchral purposes. As on the Meuse, the inhabited pits of the middle states are

found along rivers, and belong generally to the period of transition from polished stone to bronze. They are scarce, and among the most important are those of Saint Saturnin, a large neolithic station above Chambery, those of Savigny near Albano, of la Salette, and of Louvaresse (Iseria). The people of the neolithic period who witnessed the arrival of bronze, inhabited the plains, and often the borders of rivers. The banks of the Saone furnish us with many stations, o which the successive epochs appear in superposed layers; it is especially at the confluence of streams and about fords that they may be perceived.

Where the waters were tranquil, and produced but few changes, that is to say, near the lakes, the men of that period no longer used caves. They deserted terra firma and built houses above water, resting on piles. None are seen on the steep banks of lakes, as the water is there too deep, but they are found on shallow banks of sand or earth where the water is not profound, as in fords of rivers. What could have induced those men to isolate themselves in the middle of these lakes? We have not yet learned, but it is to be hoped that new observations will solve the problem. However it may be, we perceive that this custom lasted a long while, as the palafittes of the Alps comprise not only the epoch of bronze, but those which had preceded it, and those also which mark the arrival of iron. There are palafittes of the stone age at the lake of Zurich, of the bronze age at Limau, of the iron age at Neufchatel, and each of these periods is well characterized. There are certain lacustrial habitations belonging to the two periods of transition which mark the beginning and end of the bronze age, so that it is at least certain that the custom of living over water continued without interruption for a long time.

As there were found habitations built on piles in the north and center of Italy, it would be interesting to explore the lakes of Central Europe, of Greece and Asia minor, and determine how far the custom extended.

The men of the stone age consecrated natural grottoes for burial purposes, while they also made use of caves for dwellings. Thus on the Meuse, the small cave of Frontal was used as a cemetery for the men who dwelt in the cave of the Noutons. This mode of living was still existing at the appearance of bronze. This is proved by the "Grotte des Morts" near Sauve (Gard). Since 1795 d'Hombre Firmas had called the attention of geologists to this cave, but it was examined only in 1869. M. Tessier died during the first clearing out, which was afterwards accomplished in the name of the Scientific Society of Alais by Messrs. Cazalis de Fondouce and Ollier de Marichard. The cave is a sort of vertical well dug out by nature in a crevice of inferior lias. From this there have been dug a large number of bones of men, foxes, wolves, wild boars, horses, sheep, a complete funeral accoutrement, composed of arms and tools of silex, bom, or deer's horn; a quantity of jet jewelry or of black or green marble, spath and Alabaster, an awl of bronze and many iron pearls many of which were left behind with the rubbish. We will also mention among the natural caves of the first bronze period those of Labry and Baniere (Jard) which have brought to light objects similar to those already found, besides a poignard, ear-rings and bracelets of

bronze, and the caves of Gonfaron and Chateau double (Var). That of Saint Jean d'Alcas (Aveyron) discovered in 1838, was searched in 1865 by M. Gazalio. It is partly artificial. At the entrance there had been placed two large arched stones supporting the roof and forming a triangular entrance. One unfortunately has been taken away by the owner of the cave, and used as a door-step to his kiln. Among the numerous objects thrown out with the dirt by the same person, there have been picked, mingled with bones and silex, two hatchets of polished stone, pearls, a spiral and bronze ring.

The artificial sepulchral grottoes have received the name of covered alleys (allees couvertes). They are especially found in Provence, dug out of the small calcareous masonry-works which appear as islets in the fertile plains of Arles. They consist of an oval gallery open above; the walls are inclined towards each other; the top being covered with large flat stones which must, in the first place, have been covered with earth. One of them, the Grotto of Cordes, which is also called the grotto of fairies, was in turn supposed to be a Gallo-Roman cave, a Saracen prison, a Druidic monument, and, lastly, a sepulchral Grotto of Asiatic or Phœnician origin. "You first of all descend," says Mr. Cazalis, "on large rough stairs into a fore court, uncovered at present, which is in the shape of a sword; from thence you proceed, through a gallery six meters long, into the cave proper. At the mouth it is 3.80 meters wide but narrows in the rear; the walls are sloping. This trench, which is twenty-four meters long, is covered by inclined stones and the whole covered by a tumulus which is much worn. The total length is not less than 54 meters." Unfortunately, the funeral outfits of this cave were scattered, so that the epoch cannot be determined, except by its resemblance to the Grotto of Castelet in the neighborhood. The latter contained sixty centimeters (2.6634 inches) of earth and gravel, brought, to all appearances, from Gardon. On this lay the bones of about ten men, together with instruments of silex and bronze, and a saucer of pottery made by hand. For a long time *Dolmens* were looked upon as Druidic altars, a vague term which with the words "Celtic" and "Gallo-Roman" is indiscriminately used. Since they have been found, not only in Western Europe, but throughout the whole Continent, Africa and Asia, new theories have been current. Some scientists have looked upon them as spontaneous transformations from caves; others thought they recognized, from their distribution over the old Continent, the migrations of a wandering tribe, which, driven from Central Asia, would have followed the Baltic, stopping in Scandinavia, and which would then, driven from the Northern countries, England and Ireland, arrive in Gaul, then proceed to Portugal, and finally to Africa. We do not suppose that dolmens have as yet been the subject of sufficient observation in Africa and throughout Asia, nor even in the different parts of Europe, that any theory should already be substantiated.

The monuments which have received the appellation of megalithic, nearly all belong to the period of polished stone; still a large number date from the appearance of bronze. Those of the North are generally the oldest; and if we may judge of their relative dates by the quantity and quality of bronze which has been

obtained, their antiquity diminishes in proportion as you descend from North to South. This does not prove however, that dolmens originated with a race descended from the Northern countries; it would on the contrary intimate that bronze brought from the Mediterranean countries, reached the North only by slow degrees. There are 147 dolmens in the South of France in which bronze has been found: they are mostly situated in the region of Cevennes, a short distance from the Mediterranean. Several dolmens from Marne and the environs of Neufchatel have also yielded some. Those of Bretagne, with the exception of a few in which a little metal was found, belong to the neolithic period. The 147 dolmens in which bronze was found mingled with objects of stone, pottery of the second period and other objects which will be mentioned further on, form but a minority of the great number which have been explored. In the South of France alone, 700 have been opened in Ardeche, 300 in Aveyron, 160 in Lozere. It may be taken for granted, that if all belong to the period of polished stone, the people who built them witnessed the arrival, in small quantities perhaps, of the first common metal. If they had had it in abundance, they would in all probability have made arms, instruments and even ornaments of bronze instead of stone, shell, horn, or bone, for with a silicious saw they could accomplish in one day of hard labor, what with a bronze saw they could do in an hour, with an iron saw in a few minutes, and in a few seconds with a steel saw impelled by mechanical force. Let us suppose it is yet the custom to bury with a person the objects he has used during his life time, and that in five or six thousand years our graves should be opened, many circular saws would be found in England, France, Switzerland, Germany, but few in Italy, especially towards the South, still fewer in Spain, one or two in Greece, and not one perhaps throughout European and Asiatic Turkey. We do not, however, notice any migrations in our midst; the industries themselves are propagated, but the people do not migrate; a few men passing from one country to another suffice to introduce new industries. The composition of dolmens is uniform, only that bronze increases from North to South; it seems then that there existed in the Mediterranean regions, or beyond, a country from which bronze is brought and distributed throughout the Northwest of Europe.

We must now speak, from the numerous facts collected and classed by M. Chantre, of the beds of bronze which were hidden under ground and brought to light by mere chance. They are of two kinds: the *foundries* and the *tresors*, to which may be added certain stations or centers of habitation as yet not well classified, and a number of tombs in open fields, whose presence there is nothing to indicate. A foundry consists ordinarily of a mere cavity dug out of the earth, and contains, more or less complete, the materials of a bronze-founder; ingots of metal, refuse and waste metal, ashes, fragments of things of little value or worn out, or defective, and, finally, crucibles, moulds, pincers, and sometimes even new objects coming out of the moulds and incomplete. Many of such foundries have been discovered in parts of Europe, especially in France, Savoy and Germany. Should the place and statistics of each be desired, I would refer the

reader to the book above cited. The foundry of Larnaud will serve as a specimen. I have already stated how the son of Brenot the farmer, discovered it in 1865, and how, when offered by his father to a brazier of Lons-le-Saulnier it was saved by M. Zephirin Robert. After having been exhibited during the Exposition of 1867, in a store on the Boulevard des Filles du Calvaire, it was bought for the Museum of Saint-Germain. The case in which it is exhibited has been classified and labeled by M. Chantre who, in his work, gives a catalogue and full description. The value of the collection obtained from Larnaud, consists in this, that all the pieces which compose it are contemporaneous: there are 1485 such pieces, and the epoch to which they belong is evidently the end of the bronze age. This is what is shown by a comparison with those of the other foundries, and especially with the objects obtained from the palafittes of Savoy. Throughout, the last epoch of bronze is characterized by traces of the hammer, by the presence of metallic plates or leaves obtained by concussion and not merely by casting. On the other hand, that which links the workshop of Larnaud with the age when bronze was the only common metal are the cold chisels made of hard bronze to cut bronze, as steel cuts iron. But since bronze is softer than iron, can it be doubted that cold chisels would have been made of iron, if the latter metal had been known or was at least abundant? We will give further proofs showing more clearly the epoch to which we must refer the foundry of Larnaud.

There are other foundries belonging to this period, among which we will mention that of Poype, situated on the heights overlooking the Rhone to the South of Vienna. A portion of the bronze had been sold to a merchant of Lyons, at the price of old brass; it was bought by M. Chantre who, on precise indications, renewed the search and was able to duplicate the products. The foundry of Goncelin is also situated on the heights adjoining the Iser, as well as those of Thoduse and Bressieuse. The largest portion of the other stations of this kind are in the neighborhood of rivers, and probably at a short distance from the places then inhabited. What is probably the most remarkable is their uniformity throughout Europe. They indicate to all appearances, the passage or stay, long or short, of workmen belonging to the same class, but who were not natives. Foundries are, in fact, always found in isolated spots, but no traces of human habitations are seen. It is true that habitations may disappear, wooden houses crumble into dust, and the very stones become, in the course of time, dispersed and used elsewhere. There is, at any rate, one product of human industry which never disappears, and attests the presence of man during the most ancient times; that is the baked clay and especially broken pottery. Its tenacity is such, that on closely comparing the soil with some of the fragments, it is often easy to determine the place and size of cities which have disappeared several centuries ago. The neolithic foundries are never surrounded by such ruins.

There are but few lacustrial habitations where the metals were wrought, but here the natives might have been taught by travelers. The initiation seems, in fact, probable, from the existence of certain inhabited spots, which are called *stations*. Those which are known are not very extensive; in most cases they are

on a line with rivers, as may be seen, for example, on the banks of the Saone between Chalons and Tournus; still there are some isolated ones. The most important of them all is that of Saint-Pierre-en-Chastre in the forest of Compiegne. It is situated on the calcareous plateau in the swampy plains of Vieux-Moulin. It was dug by M. Viollet-le-Duc in 1860, and yielded, among other things, more than five hundred bronzes, which are indistinctly attributed to Gaelic armies. Since then, science having made some progress, they have found that it is necessary to distinguish the objects of stone, bronze, or iron obtained in that locality; that all was anterior to the time of Cæsar; that there were few arms; that the quality of bronze was identical to that of the other layers of that age throughout Europe. On close examination, comparisons showed that the stations of Saint-Pierre had probably existed for several centuries, and that it had witnessed if not the first appearance of bronze in that country, at least the epoch of that metal, and the commencement of the iron age.

But the interest in the stations is, in part, lost in that of the *tresors*, as these seem to demonstrate the reality of the traveling founders; the idea merely being suggested by the foundries. The most important were found in the Alps on the neck of the mountains, some near Moulins and Gannat, two in Meusth, and one near Sarrelouis; there are altogether twenty-nine in France, comprising upward of 1350 pieces.

These treasures are composed of new objects, never having been used; sometimes several are joined together, having been cast in the same mould.

They are found in small cavities expressly dug, where they seem to have been hidden for a short time by their possessors. These treasures, those of the Alps at least, are often found on high ground, not far from roads, frequented by travelers going from one country to another. There are no signs of a foundry in the vicinity, or even of a station, the spots where they were found are deserts. Is there anything to be found in these temporary deposits besides objects of traffic? Were they not hidden by the same men who, in the valleys, recast the inferior products of their own industry? If all this leads us to believe that such is the origin of the treasures, there would only have to be determined the direction in which these workmen went, to know whether they came from Italy to France, or vice-versa. It will directly be seen that this difficult problem is no longer insoluble to day.

The treasure of Reallon, which is now in the museum of Saint-Germain, was found in that village not far from Embrun 3880 meters high. "This road, anciently frequented by foot-travelers, leads from Saint Bonnet to Embrun, by Gociere." The treasure of Beauviears was found by a farmer. This village of the arrondissement of Die is situated on an ancient passage of the mountains, on the peak of Calre, on the road to Luc. There were many other valuables which had been stowed away on the upper banks of rivers, as well as on the plains. —*Van Nostrand's Magazine.*

PRE-HISTORIC MOUNDS IN KANSAS.

On a high bluff, about six miles west of town, near the residence of Mr. J. B. Stuart, on the Smoky Hill, stands an ancient mound, which was first noticed last September by Mr. George Wiseheart, of Illinois, while visiting in the family of Mr. Stuart. Mr. Wiseheart made some slight excavations into the mound, and, upon finding some remains of human bones, he reported the fact in town, which led some gentlemen to determine to explore it still further.

Accordingly, on Thursday, November 28th, a party visited the place, and there found the mound to be a very prominent object on the hill, and composed of stones, large and small, filled out with earth. The stones have all been brought to the spot and deposited by human hands, as no rock exists in its immediate vicinity. The whole work is about twenty-five feet in diameter, and is maniform in shape. There has been no attempt at anything like masonry in its structure, but the stones are arranged in curious, irregular circles, the inner one at the top of the mound being about six feet in diameter, surrounded by others of similar size, and still others smaller. There are numerous others of these circles made all around the mound, on every side, but more numerous on the south and southeast sides. They vary greatly in dimensions, but are all of the same general appearance, and cover quite a large extent of surface.

From the appearance of these circles within circles, it was thought that the mound might originally have been pyramidal, but the wear and tear of ages and rains and tempests have reduced it to its present form.

Upon digging into the tumulus many of the stones were found arranged into rude arches, but this was not general as far as explored.

Quite a quantity of bones and teeth were found, some human, some of large animals, and some belonging to rodents, but all were in such a decayed and fragmentary condition that it was not possible always to distinguish them particularly. Several small pieces of human skull were there, but none large enough to discover the race of the individuals. Some of the animal bones have evidently been subjected to the action of fire, and pieces of burnt clay or brick also indicated the presence of fire, though not a particle of charcoal was seen.

It was impossible to distinguish the manner in which the dead were buried, whether lying or sitting or doubled up, or in which direction the head or heads lay, as the bones were mingled indiscriminately in the most confused manner, a piece of skull lying in juxtaposition to a toe or hip bone, with the tooth of an unguiculate animal or the jaw of a small rodent close by.

No weapons or implements either of stone or bone were found, except some fragments of pottery, and these very small and composed of a peculiar black silicious clay, and some small tubes of bone, ornamented on the outside with spiral cuttings of a knife, and one little bone button.

Who built this tumulus? Some mounds in the United States have been assigned an age of two thousand years, and we have no doubt, judging from the state of decay of its contents, that this one is among the oldest.

For what purpose it was built is another interesting question. It is on the top of a high hill, and no alteration in the face of nature could ever have driven a brook or other stream from its vicinity. Water is too far away to allow the supposition that it ever was a permanent dwelling place.

The bluff on which this relic stands, although it has a very steep and abrupt south face, has a gradual and long slope towards the east. The mound does not stand on the summit of the hill, but a little way down this eastern slope, and this with the peculiar little irregular circles of stone, with the charred bones of animals and the presence of fire, seem to make the most probable conjecture as to its origin to have been on some great sacrificial occasion, following the death of some great chieftain or renowned man, when all the people assembled for a period of mourning for the great or loved departed; looking to the east as the source of light and the hope of the tribe that the darkness of the tomb might thence in the distant future be illumined.—*Junction City Union, Dec. 7.*

CHEMISTRY.

LOCKYER ON THE NATURE OF THE ELEMENTS.

At a crowded meeting, such as is seldom witnessed, of the Royal Society on Thursday evening last, Mr. J. Norman Lockyer, F. R. S., read a lengthy paper, in which he discussed the evidence derived from spectroscopic observation of the sun and stars and from laboratory experiments, which has led him to the conclusion that the so-called elements of the chemist are in reality compound bodies. In order that the line of argument followed by Mr. Lockyer may be understood, it will be necessary briefly to refer to the results of previous researches. As a rule, in observing spectra, the substance to be examined is volatilized in a gas flame or by means of sparks from an induction coil, and the light is allowed to fall on the slit of the spectroscope; the spectrum is then generally one in which the lines run across the entire field, but by interposing a lens between the spark apparatus and the slit of the spectroscope, Mr. Lockyer was enabled to study the various regions of the heated vapor, and thus to establish the fact, already noted by some previous observers, but to which little attention had been paid, that all the lines in the spectrum of the substance volatilized did not extend to equal distances from the poles. He then showed by the aid of this method that in the case of alloys containing different proportions of two metals, if the one constituent were present in very small quantity its spectrum was reduced to its simplest form, the line or lines longest in the spectrum of the pure substances alone appearing, but that on increasing the amount of this constituent its other lines gradually appeared in the order of their lengths in the spectrum of the pure substance. Similar observations were made with compound bodies. It was also

noticed that the lines furnished by a particular substance varied, not only in length and number, but also in brightness and thickness according to the relative amount present. Armed with these facts, and with the object of ultimately ascertaining more definitely than has hitherto been possible which of the elements are present in the sun, Mr. Lockyer about four years ago commenced the preparation of a map of a particular region of the spectra of the metallic elements for comparison with the map of the same region of the solar spectrum. For this purpose about 2,000 photographs of spectra of all the various metallic elements have been taken, and, in addition, more than 100,000 eye observations have been made. As it is almost impossible to obtain pure substances, the photographs have been carefully compared in order to eliminate the lines due to impurities; the absence of a particular element as impurity being regarded as proved if its longest and strongest line was absent from the photograph of the element under examination. The result of all this labor, Mr. Lockyer states, is to show that the hypothesis that identical lines in different spectra are due to impurities is not sufficient, for he finds short line coincidences between the spectra of many metals in which the freedom from mutual impurity has been demonstrated by the absence of the longest lines. He then adds that five years ago he pointed out that there are many facts and many trains of thought suggested by solar and stellar physics which point to another hypothesis—namely, that the elements themselves, or, at all events, some of them, are compound bodies. Thus it would appear that the hotter a star the more simple its spectrum; for the brightest, and therefore probably the hottest stars, such as Sirius, furnish spectra showing only very thick hydrogen lines and a few very thin metallic lines, characteristic of elements of low atomic weight; while the cooler stars, such as our sun, are shown by their spectra to contain a much larger number of metallic elements than stars such as Sirius, but no non-metallic elements; and the coolest stars furnish fluted band spectra characteristic of compounds of metallic with non-metallic elements and of non-metallic elements. These facts appear to meet with a simple explanation if it be supposed that as the temperature increases the compounds are first broken up into their constituent "elements," and that these "elements" then undergo dissociation or decomposition into "elements" of lower atomic weight. Mr. Lockyer next considers what will be the difference in the spectroscopic phenomena, supposing that A considers B as an impurity and as a constituent. In both cases A will have a spectrum of his own. B, however, if present as an impurity, will merely add its lines according to the amount present, as we have above explained; whereas if a constituent of A, it will add its lines according to the extent to which A is decomposed and B is set at liberty. So that as the temperature increases the spectrum of A will fade if A be a compound body, whereas it will not fade if A be a true element. Moreover, if A be a compound body, the longest lines at one temperature will not be the longest at another. The paper chiefly deals with a discussion from this point of view of the spectra of calcium, iron, hydrogen, and lithium as observed at various temperatures; and it is shown that precisely the kind of change which is to be expected on the hypoth-

esis of the non-elementary character of the elements has been found to take place. Thus each of the salts of calcium, so long as the temperature is below a certain point, has a definite spectrum of its own, but as the temperature is raised the spectrum of the salt gradually dies out, and very fine lines due to the metal appear in the blue and violet portions of the spectrum. At the temperature of the electric arc the line in the blue is of great intensity, the violet H and K lines, as they are called, being still thin; in the sun the H and K lines are very thick, and the line in the blue is of less intensity than either, and much thinner than in the arc. Lastly, Dr. Huggins's magnificent star photographs show that both the H and K lines are present in the spectrum of *a* Aquilæ, the latter being, however, only about half the breadth of the former; but that in the spectrum of *a* Lyræ and Sirius only the H line of calcium is present. Similar evidence that these different lines may represent different substances appears to be afforded by Professor Young's spectroscopic observations of solar storms, he having seen the H line injected into the chromosphere 75 times, the K line 50 times; but the blue line, which is the all-important line of calcium at the arc-temperature, was only injected thrice. In the spectrum of iron, two sets of three lines occur in the region between H and G which are highly characteristic of this metal. On comparing photographs of the solar spectrum and of the spark taken between poles of iron, the relative intensity of these triplets is seen to be absolutely reversed; the lines barely visible in the spark photograph being among the most prominent in that of the solar spectrum, while the triplet, which is prominent in the spark photograph, is represented by lines not half so thick in the solar spectrum. Professor Young has observed during solar storms two very faint lines in the iron spectrum near G injected 30 times into the chromosphere, while one of the lines of the triplet was only injected twice. These facts, Mr. Lockyer contends, at once met with a simple explanation if it be admitted that the lines are produced by the vibration of several distinct molecules.

The lithium spectrum exhibits a series of changes with a rise of temperature precisely analagous to those observed in the case of calcium.

In discussing the hydrogen spectrum, Mr. Lockyer adduces a number of most important and interesting facts and speculations. It is pointed out that the most refrangible line of hydrogen in the solar spectrum, *h*, is only seen in laboratory experiments when a very high temperature is employed; and that it was absent from the solar protuberances during the eclipse of 1875, although the other lines of hydrogen were photographed. This line, also, is coincident with the strongest line of indium as already recorded by Thalen, and may be photographed by volatilizing indium in the electric arc, whereas palladium charged with hydrogen furnishes a photograph in which none of the hydrogen lines are visible. By employing a very feeble spark at a very low pressure the F line of hydrogen in the green is obtained without the blue and red lines which are seen when a stronger spark is used, so that alterations undoubtedly take place in the spectrum of hydrogen similar to those observed in the case of calcium. In concluding this portion of his paper, Mr. Lockyer states that he has obtained evidence

leading to the conclusion that the substance giving the non-reversed line in the chromosphere, which has been termed *helium*, and not previously identified with any known form of matter, and also the substance giving the 1474 or coronal line, are really other forms of hydrogen, the one more simple than that which gives the *h* line alone, the other more complex than that which gives the F line alone.

There can be no question that the facts brought forward by Mr. Lockyer are of the highest importance and value, and that they will have much influence on the further development of spectrum analysis, to which he has already so largely contributed. But his arguments are of a character so totally different from those ordinarily dealt with by chemists that they will hesitate for the present to regard them as proof of the decomposition of the elements until either they are assured by competent physicists that they cannot be explained by any other equally simple and probable hypothesis, or until what Mr. Lockyer has foreshadowed as taking place to such an extent in other worlds has been realized beyond question or cavil in our own laboratories. It has been suggested that the same molecule may be capable of vibrating in different ways at different temperatures, and thus of yielding different spectra, just as a bell may give out different notes when struck in different ways; and although Mr. Lockyer has replied to this objection, it can scarcely be regarded as finally disposed of. The fact, however, as Mr. Lockyer has pointed out, that the change from the spectrum of a compound to the lowest temperature spectrum of a metallic element is of a similar character to and even less in degree than the change from the lowest temperature spectrum of the metal to the spectra which it furnishes at higher temperatures does not appear to favor such an hypothesis, and from the similarity in the phenomena it is difficult to deny that in both cases decomposition does not equally take place. Prof. Young's observations on the injection of particular lines into the chromosphere during solar storms are also difficult to reconcile with this view, and if the conclusions drawn from previous researches are correct, it also does not account for the short line coincidences which led Mr. Lockyer to his hypothesis.

Chemists are careful to teach that what are at present regarded as elements are not necessarily simple bodies, but merely substances which they are unable to decompose or which they have no special reason to regard as compound bodies. The remarkable relations, both in atomic weight and properties, existing between many of the elements, tend, indeed, to show that they are related in the manner Mr. Lockyer supposes. We sincerely hope that he will continue his researches in this direction, and we trust that at no very distant time he may be able to bring forward evidence sufficiently clear to convince even the most skeptical.—*Chemical News, Dec. 20.—From London Times.*

METEOROLOGY.

MEMORABLY COLD WINTERS.

COMPILED BY THE EDITOR.

The severity of the present winter having been regarded as in a high degree remarkable by many, it has occurred to the writer that a brief compilation from various sources, embracing an account of unusually cold winters at various times and places might prove of decided interest to the general reader. For this purpose alone the following paragraphs have been thrown together:

Dr. Kane, while wintering in Smith's Sound, (78° 37′ North latitude) in the winter of 1853, probably experienced the most intense cold ever felt by man. He says of it: "On the 17th of January our thermometers stood at −49°, and on the 20th the range of those at the observatory was −64° to −67°.

On the 5th of February our thermometers began to show unexampled temperature. They ranged from −60° to −75°, and one very reliable instrument stood upon the taffrail of our brig at −65°. The reduced mean of our best spirit-standards gave −67°, or −99° below the freezing point of water.

At these temperatures chloric ether became solid, and carefully prepared chloroform exhibited a granular pellicle on its surface. The exhalations from the surface of the body invested the exposed or partially clad part with a wreath of vapor. The air had a perceptible pungency upon inspiration, and when breathed for any length of time it imparted a sense of dullness to the air-passages."

The lowest temperature recorded by any of Dr. Kane's thermometers, was −80°, afterwards corrected with ten other bulb instruments and reduced to a mean of −68° or 100° below freezing point of water. On the 7th of January 1855, the reduced mean of the lowest temperature was −69.3.

Dr. Hartwig says: "About the same time, (Feb. 9th and 10, 1854) Sir E. Belcher experienced a cold of −55° in Wellington Channel, (75° 41′ N.) and the still lower temperature of −62° on January 13th, 1853 in Northumberland Sound, (76° 52′ N.). Whymper, on December 6th, 1866, experienced −58° at Anatto, Alaska, (64° 42′ N.)."

Capt. Howgate, in his interesting article in the *North American Review*, on "The Cruise of the Florence," says, that the coldest day experienced by her navigators, was in Annanatook Harbor, January 21st, 1878, when the mercury fell to −52°.

In Portland, Maine, the mercury reached its minimum point in the winter of 1856 at −18°; in Boston, at −13°; in Albany, at −25°; in Pittsburg, at −12°; in St. Paul, at −35°; in Ft. Laramie, at −14°; in Ft. Kearney, at −12°; in Leavenworth, at −20°; in Cincinnati, at −11°, and in St. Louis, at −5°.

The Kansas City *Journal* quotes from its old files:

"On the night of the 24th of December, 1855, the Missouri River at this place was frozen over. It is now near five weeks that the river has been a highway for teams of horses, mules and oxen. We put this fact on record for coming years. We have now had near seven weeks of hard freezing weather. A fact unparalleled in the history of this country; People will hereafter refer to the long cold winter of 1855–56. The Indians say it is the severest known for a quarter of a century, nothing like it being seen by the present generation." And under date of Saturday, February 2d, 1856; "The cold weather of the past few weeks has been general. From every part of America—from Halifax to Cuba we have accounts—and it is everywhere spoken of as the coldest ever known. At Memphis the citizens are putting up their own ice, a circumstance ununknown before. The floating ice has reached the mouth of the Mississippi— a fact unheard of even to tradition. The Brazos River in Texas is frozen sufficiently hard for the crossing of teams. In Cuba they have a real Northern winter. At St. Paul, Minnesota, the thermometer has been 41 degrees below zero."

And again on February 9th, one week later still. "The cold weather continues unabated. On Sunday and Monday (3d and 4th) the thermometer stood 28 and 30 degrees below zero. We have been looking for Dr. Kane for the last four weeks."

And finally March 1st. "The river at this place broke up on Monday morning last, the 25th of February, 1856—having been closed *sixty-two* days. The shore is piled with broken ice at the present writing, but the channel is almost entirely clear. We have no advices from above and cannot say how far it is open. To-day (Friday) it is snowing heavily, the ground being completely covered."

The coldest days within twelve years in this city have been February 6th, 1872, when the thermometer marked −12° at 7 a. m.; December 24th, 1872, −16° at 7 a. m.; January 20th, 1873, −21° at 7 a. m.; January 16th, 1877, −12°; December 16th, 1878, −16° at 7 a. m.

The present winter has been a phenomenal one in the United States, by reason of universal snow storms and cold weather. The severity of the latter is attested by the records of the Signal Service Corps. On January 2d, at 3:42 p. m., the thermometers at the various signal stations marked as follows:

Chicago, Ill., −9°; Davenport, Iowa, −14°; Indianapolis, Ind., −4°; La-Crosse Wis., −10°; Leavenworth, Kas., −3°; Omaha, Neb., −5°; St. Louis, Mo., −1°; St. Paul, Minn., −8°; Yankton, D. T., −16°, while the snow varied in depth at the same stations, from six inches to two feet.

For the extremes of cold reached in former times we have no authority at hand more ancient than Horace, who thus records the weather in Rome along about the year 25 B. C.

"Vides ut alta stet nive candidum
Soracte, nec jam sustineant onus
Silvæ laborantes geluque
Flumina constiterint acuto."

Flammarion, in his work on The Atmosphere, devotes a chapter to a description of the extremely cold winters within one hundred years prior to 1872. In 1776 the Tiber, the Rhine, the Seine and even the Rhone, rapid as it is, were nearly entirely frozen over. The winter of 1788–9, the precursor of the French Revolution, was one of the longest and most severe winters that ever prevailed in Europe. In Paris the cold commenced on November 25th and lasted fifty consecutive days, commencing to thaw January 13th, when the snow was found to be twenty-six inches thick. In the great canal at Versailles the ice was two feet thick. Water froze in very deep wells and wine became congealed in cellars. The mercury at Paris on the 31st of December, was −7.2°

The cold was equally severe elsewhere. At Lyons and at Toulouse the Rhone and the Garonne were frozen over, and even the sea itself for several leagues off the Atlantic coast. The Rhine was crossed with loaded wagons and the Elbe with heavy carts. People rode on horseback over the harbor at Ostend, and during the Christmas holidays the Thames, in the neighborhood of London, was covered with shops. In Toulouse the very bread was laid before the fire to be warmed and then broken with a hatchet; in Galicia, near the end of December, thirty-seven persons were found dead in three days, and the very fish perished in the ponds in France. In Bâle, in Switzerland, the thermometer marked −35°; at Warsaw, in Poland, −26°; at Dresden, −25°; at St. Petersburg, −23°; at Strasbourg, −45°; at Tours, −13°, and at Marseilles the lowest point reached was on the 31st of December, when the mercury stood at −1.4° Fahrenheit. The winter of 1794–75 was also very severe, the mercury sinking at Paris, on the 25th of January to −10.11°, being the coldest day ever known there. Pichegru, then in Holland, sent a detachment of cavalry across the Texel with orders to capture the vessels of the enemy caught at anchor in the ice. During that of 1798–99 the Meuse, the Elbe, the Rhine and the Seine were frozen over, and a regiment of dragoons, starting from Meyence, crossed the Rhine upon the ice instead of at the bridge at Cassel, which had been removed. The lowest temperature marked, was 0.3°, December 10th 1798.

The winter of 1812–13 will ever be remembered in history. It witnessed the retreat of the French army from Russia amid all the horrors that succeeded the capture and the conflagration of Mosoow. The retreat began on the 18th of November, and was complete on the 23d. On the march to Smolensk the snow fell almost without ceasing. On the 17th the temperature fell to −15°02 according to Baron Larry, and some of the Russian artillery crossed the Dwina upon the ice. From the 26th to the 29th, during the crossing of the Berezina, the river was choked with blocks of ice loosened by the thaw, which began on the 24th. The severity of the weather was soon as great as ever, and on the 30th of December, the mercury fell to −13°; on December 3d, to −22°, and on the 6th of December, the mercury stood at −35°.

In January, 1820, at St. Petersburg, a temperature of −25.6° was recorded, −11.9° at Berlin, and in France several travelers, farmers and game-keepers were frozen to death. The winter of 1829-30 was also a very cold one. In St.

Petersburg the mercury sunk to −26°; at Nancy, to −15.3°; at Strasbourg to −10.1°, and at Metz, to −4.9°. In Paris the lowest point was −1°. In Switzerland the cold was very severe in the great altitudes. In Yverdun in the plains the thermometer fell in a few hours, from 14° above, to −4°, and polar snow, the crystalization of which is very close and which is peculiar to very low temperatures, was observed. The Seine was frozen over from the 28th of December to the 26th of January, and afterward from February 5th to the 10th, making thirty-four days in all. On the 25th of January, after a thaw, the ice from Corbeil and Melun blocked up the bridge at Choisy, forming a wall sixteen and a half feet high. On the 15th of December, 1840, the ashes of Napoleon, brought home from St. Helena, entered Paris under the Arc de Triomphe, and Flammarion says:

"The thermometer exposed to nocturnal radiation had that day marked −6.8°, Fahrenheit. An immense crowd, the National Guard of Paris and its suburbs, and numerous regiments, lined the Camp Elysees from the early morning till two in the afternoon. * * * Soldiers and workmen, hoping to obtain warmth by drinking brandy, were overpowered by the cold and dropped down dead of congestion. Several persons perished, victims of their curiosity; having climbed up into the trees to see the procession, their extremities, benumbed by the cold, failed to support them, and they were killed by the fall.

January 2d, the thermometer at the observatory at Mont St. Bernard marked −9.9°. The winters of 1853–4 and 1854–5 were also very rigorous, especially in Southern Russia, Denmark, England and France. The Rhone, the Saone and the Rhine were all frozen over, and in January, 1858, the Danube and even the Russian ports in the Black Sea. The winter of 1854–5 was more severe. The mercury reached −19.8° at St. Petersburg and −14.4° at Riga. The Seine was frozen over at Paris and people crossed it.

The winter of 1870 and 1871 is also memorable in the history of warfare, and from the fatal influence of the cold upon the health of the combatants. Many of the outposts around Paris and several of the wounded were found frozen to death on the field. The winter average there was nearly −3° lower than usual, and M. Renou observed −9.4°at Perigueux and −13° at Moulins. Flammarion sums up the results of a number of tables of low temperature with the following statement:

The greatest cold yet experienced has been −24° in France; −5° in England; −2° in Holland and Belgium; −67° degrees in Denmark, Sweden and Norway; −46° in Russia; −32° in Germany; 0° in Italy; −10° in Spain and Portugal. * * In non-European countries it is certain that at Fort Reliance, in British North America, there have been −70° of cold, and at Semipalatinsk −76°.

M. Renou has noticed that the severest winters seem to recur about every 40 years: 1709; 1749; 1780; 1830; 1870.

A REVIEW OF THE WEATHER CONDITIONS OF THE FIRST WEEK OF THE YEAR 1879.

BY ISAAC P. NOYES, WASHINGTON, D. C.

It is seldom that we have two such opposite and positive conditions come so near together as passed over the country the first few days of the new year. The first was a severe cold wave from the west that affected all that portion of the country east of the Rocky Mountains; the second, immediately following it, was a warm wave following the same general course. A few years since we could not have satisfactorily explained this, but by the facts accumulated by the Signal Office we are now able to make the whole phenomenon so plain "that even those who run may read" and understand. Without going too deep into the science of the matter, the cause of these changes in the weather is what is known as low barometer, which *draws* the currents of air towards it with more or less force from all directions, and the force depends upon the singleness, positiveness, and concentration of this center of *low*. When there is only a single *low* the effect—other things being equal—will be more powerful than where there are two or more centers to divert the force.

In these late "conditions" the theory herein advanced corresponds, both *before* and *after*, with the facts gathered from the map published by the Signal Office. These facts can be readily understood by those who have a knowledge of common physics, and with this knowledge they may readily comprehend such a storm. The center of low barometer may start anywhere, but when once started travels in a *general* easterly direction—the same as the Mississippi River courses to the south, though we know that there are local points where it courses even to the north. The first low started in the southwest—in Texas. At least here is where we first took it up. We have no stations south of the Rio Grande, yet it would be well if we had—it would be a great addition to the weather service. This *low* travelled towards the northeast for a short distance, that is, the center of it did, but as a whole, after going northeast, it took a more easterly direction to the Atlantic Ocean. We were not able to trace it beyond the boundary of the ocean. Here is a barrier that we cannot at present pass, though we may hope to some day. But from our knowledge of the manner in which the wind travels we can trace up the center of *low* with as much certainty as a well-trained Indian follows a trail. This cold storm, upon which pages might be written, was the result of a single, positive and concentrated area of low barometer traveling in its regular course towards the east. This is the only view that the facts gathered by the Weather Bureau will support, and it is at once reasonable and satisfactory, as the sudden change of the 7th and 8th of January, in the same portion of the United States, will conclusively prove. Mild weather with southerly winds followed this cold blast from the west. Why? is the question. The facts on which this article is based will readily demonstrate why, and that is more than any other known theory will do, and for this if for nothing more it should be accepted,

even if not as the whole truth, as the most true revelation yet known to man to explain the weather problem. The simple cause of this great change is that in this second case *low* barometer started in the northwest and traveled on nearly a straight line east. Traveling on a higher line of latitude it caused the wind in the United States west of the Rocky Mountains to be from the warm sections of the south.

Recently it has been advanced by some one that "according to the latest view of the weather the cold attending these great waves which roll over the country does not come from a distance, but from overhead." The person who promulgated this idea did not seem to think when writing it what his words here imply. If these cold waves come from overhead they may come from even a greater distance than the theory above referred to could reckon. For "overhead" implies more millions of miles than we can conceive of. Of course, all know that above the earth a short distance the air is intensely cold. Those who hold to these views of the weather neither ignore this nor have need to speak of it. We must necessarily deal with the air of our globe as we find it near the surface of the earth—in the stratum that supports life. There is no *chance or unknown disturbance* that creates these effects. They are as well known as any physical facts in any well-known department of knowledge, and to explain them there is no need mysteriously to call on "electricity" or "disturbances of equilibriums," etc. Such terms may sound very nice, but they are meaningless when used in this blind connection. They answered very well when we were in darkness as to the whole subject, but in the light of the present knowledge they are mere foolishness. Our globe rolls through space, and of course we must be affected by the atmosphere that surrounds us, but as our great waters remain with us and form a part of us so does our atmosphere—the atmosphere that supports us in life. It remains with us, no matter how much it may mix and intermix with the ether beyond. It forms a mass by itself, and this mass obeys certain known laws that are now well recorded in the weather maps of the day.

To sum up the changes in the weather, they are caused by the winds being *drawn* toward the center of low barometer. This center of low barometer is ever changing, although its full changes we are not familiar with, for the barrier that the expanse of oceans presents prevents us. *Low* always travels in an easterly direction. If the earth turned on its axis toward the west the direction would be reversed. If low barometer travels on a high line of latitude it will cause it to be warm south of that line. If on a low line it will cause it to be cold north of that line. Cold winds come from the north, warm winds from the south, and as winds partake of these two elements they will be either cold or warm. In a short article like this, one cannot be as explicit as he would like to be. There are many influences ever at work that cause changes in our weather system, and that make even similar conditions so vary in detail or at different times as to produce quite different results. These two conditions, however, that passed so near in line to each other and that yet were so different in their effects, afforded a fine study and a fine test of the system that is at present followed with so much

satisfaction. It is, however, comparatively a new subject, and it remains yet to have volumes written upon it; but no matter how many volumes are written upon it, those who are most familiar with the subject as revealed in the weather maps that are daily published, feel confident that additional knowledge will support rather than refute the ideas herein set forth.

BOOK NOTICES.

GEOLOGIST'S TRAVELING HAND-BOOK AND GEOLOGICAL RAILWAY GUIDE, by James MacFarlane, New York; D. Appleton & Co., 1878-9. 216 pp. $1.50

This neat little book is, as it states, a complete railway guide of the United States and Canada, with notes of the geology opposite each station. It is convenient and handy for the tourist. It is a condensed compendium of the geology of the whole United States through or near where any railroad passes.

Its author, James MacFarlane, is also the author of a valuable work on The Coal Regions of America, already passed through several editions. The present work is the result of his own accurate observation and the co-work of the various State Geologists and other scientific gentlemen of the United States, and should be in the hands of all geologists. In a condensed form it contains the latest correct geological information of our country. We have here nearly fifty pages of introductory remarks descriptive of the various formations known in the United States, arranged according to Dana's latest tables. These descriptions are short, clear and instructive.

In this book we find an interesting contribution from T. Sterry Hunt on the eozoic (archaian azoic). Mr. Hunt has probably studied these ancient rocks more closely than any other person, and for more detailed descriptions we would refer to his valuable work "Geological Essays," but here we have the result of his latest studies in a very few pages, of which the following is an abstract:

These rocks he describes beginning with the oldest, and names them 1 (a) Laurentian, 1 (b) Norian, 1 (c) Huronian, 1 (d) Montalban.

(1 a) The *Laurentian* is a strong, massive gneiss, reddish or grayish in color, sparingly micaceous, but often hornblendic. The gneisses are for the most part distinctly stratified, but occasionally the evidence of stratification is not very apparent, so they are often denominated granites. (Mr. Hunt only applies the name granite to a species of eruptive rocks—to similar metamorphic rocks he seems always to apply the term gneiss.) The series is distinguished by the absence of chloritic, talcose, argillaceous or micaceous schists, but includes crystalline limestones, of which there are supposed to be more than 1,000 feet of thickness on the Ottawa. Great masses of magnetic iron are inter-stratified, and we also have graphite. These rocks form the Laurentide Mountains of Canada, Adirondacks

of New York, Highlands of the Hudson, Gneiss (granite) of Richmond, Va., Roan Mountain of North Carolina, Gneisses of Western Islands of Scotland, of Scandinavia and Finland, and of some of the Alps. In this formation occurs the strange foraminiferal organism called Eozoon Canadense—the first evidence of organic life.

(1 b) To the *Norian* Dr. Hunt refers the upper portion of the Laurentian on the Ottawa, made up of labradorite or related anorthic feldspar, with some true gneisses and crystalline limestone. A similar terrene occurs in Norway, also resting unconformably on the older Laurentian, to which the name of Norete has been applied. Red garnet, green epidote, biolite and ilmenite are often present. Great beds of titaniferous iron abound in the Norian series. This terrene covers several hundred square miles in Essex county, New York, where it rests unconformably upon the Laurentian. An extensive area also exists on the coast of Labrador.

(1 c) *Huronian.* These are found on the north shore of Lake Superior, part of the Huron Mountains south of Lake Superior, some rocks of Newfoundland, part of Green Mountain series and southwestwardly along the Blue Ridge, northeast of Bay of Fundy, along the coast of Maine, Massachusetts and Rhode Island. They are everywhere highly disturbed and are many thousand feet thick. They are chiefly porphyries or petrosilex rocks or dionrites which are often chloritic Steatites and dark-colored serpentines abound in parts of the series. They contain the specular and magnetic iron ores of northern Michigan and similar ores in southeast Missouri. A series of rocks which Dr. Hunt has referred to the Huronian appears in parts of the British islands, viz.: In Donegal, Ireland, in Auglesea, in Caernarvonshire. Rocks underlying the Lower Cambrian in South Wales, to which the name of Dimetian has lately been given, seem also to belong to the Huronian. The gold-bearing rocks of California belong both in these crys alline schists and in the eruptive granites.

(1 d) *Montalban.* These rocks are said by Dr. Hunt to be lithologically and geognostically distinguished from the Huronian, and are well displayed in the White Mountains of New Hampshire, hence the name. They occupy large areas in New England, and constitute the gneisses and mica schists of New York Island, of Philadelphia, Baltimore and Washington, and at the summit of the Huronian in Northern Michigan. In Virginia and North Carolina they are gold-bearing. These gneisses are distinguished from those of the Laurentian by being finer grained and having white feldspar. Hornblende prevails, and the gneiss passes into a bluish black hornblende rock. The mica schists are remarkable for the abundance of crystallized garnet, stanolite, chiastolite and cyanite.

The only serious error I find in this work is one in which the author says that lead at Granby and Joplin occurs in sandstone of the age of millstone grit. To be sure, in the valleys are found masses of sandstone—also on the hill-tops, but the hills on which lead and zinc are found are essentially of limestone with much chert, carrying fossils of the age of the Keokuk group, but on higher ground some fossils present types of the Chester group. G. C. BROADHEAD.

EDEN DELL OR LOVE'S WANDERINGS, AND OTHER POEMS, by George W. Warder, Kansas City, Mo.; Ramsey, Millet & Hudson, 1878. pp. 358. 12 mo.

This volume is mainly a tribute of affection to the memory of a deceased wife, and as such must necessarily be regarded kindly. We find in it many excellent things, many passages showing that the author is possessed of fine imaginative powers, genuine poetic fancies, and an education commensurate with the demands of the work he has undertaken. Faults the work certainly has, but it is evident that they are due in a great degree to haste in composition and the preparation of the book, and will be corrected in a second edition, which we hope will soon be called for.

The printing and binding reflect great credit upon the taste of both author and publishers.

EVOLUTION OF SOUND, by Wilford, Hall & Co., New York, 1878. Octavo, paper. pp. 260.

This is part of a work by an anonymous writer, called The Problem of Human Life, Here and Hereafter, in which the wave theory of sound is assailed and a new hypothesis proposed, i e., that of substantial, sonorous corpuscles. In this day of surprises, when Lockyer announces that the chemical elements are compound in their nature, and hydrogen the basis or starting point of everything; when Professor Crookes demonstrates that matter exists in four states or conditions instead of three, as heretofore believed; and Tyndall reasons out the deduction that there is no God, but that every step in the phenomena of life can be accounted for without invoking the supernatural, we are prepared for any innovation whatever, and are not prepared to reject any hypothesis in natural science no matter how startling and reversive of accepted teachings. The author of the volume under consideration starts with the hypothesis that sound must be a substantial entity, consisting of corpuscular emissions or some kind of atomic emanations, and shortly formulates the law governing the generation of sound or tone in these words: "It is not the mechanical effect of the numerous short motions back and forth upon the surrounding air which generates the tone of the fork or string, but it is the molecular effect of the sudden stops and starts on the atomic structure of the instrument itself, causing thereby the emission of the substantial pulses we call sound."

The writer proceeds to prove this law by showing the apparent fallacy of the wave theory as taught by Tyndall and Helmholtz, and by several illustrations which he claims explain all the phenomena of sound on his basis alone. He sets forth, among other arguments, that if the wave theory is correct a locust must exert millions of tons of mechanical force by the motion of its legs, and claims that the experiments of the United States Signal Corps with sirens and fog-horns prove conclusively that sound is a substance, which can push through the resistance offered by the highest adverse winds.

The line of argument is bold and aggressive, and, at the same time, ingenious, and the illustrations forcible, and while in the light of present theories, sup-

ported by experiments with the newly-invented phoneidoscope, not prepared to admit the conclusions without further examination, we can candidly say that it is a work deserving careful study and consideration. S.

ATTI DELLA SOCIETA TOSCANA DI SCIENZE NATURALI. Vol. III. Fasc. 1. Pisa, 1877. pp. 200. Large octavo.

We have received the above-named report from Prof. Antonio D'Achiardi, Secretary, and find it a fine specimen of the printer's art. It is also beautifully illustrated with lithographic plates of excellent workmanship. We hope to find among our scientific friends some one who is capable of giving this report an intelligent perusal and a critical review of it for a future number of the REVIEW.

SCIENTIFIC MISCELLANY.

THE FOURTH STATE OF MATTER.

Another sensation has lately been created in scientific circles by the announcement that Professor Crookes, of London, has discovered a fourth state or condition of matter in addition to those of fluidity, solidity and gaseity, hitherto regarded as comprehending all of its phases. The modern theory of the gaseous state is based upon the supposition that a given space contains millions upon millions of molecules in rapid movement in all directions, each having millions of encounters in a second, both the rapid movements and the contacts being necessary conditions of the gaseous state.

The Professor's line of argument is, that setting up an intense molecular vibration in a disk of metal by electrical means excites a molecular disturbance which affects the surface of the disk and the surrounding gas. The diameter of the dark space which appears round the negative pole of an ordinary vacuum tube when the spark from an induction coil is passed through it, varies with the degree of the exhaustion of the gas in the tube, but not with the distance separating the magnetic poles, nor with the alteration of battery power or intensity of spark; the form remains unchanged without regard to the intensity of the brilliancy of the spark. Hence he concludes that the layer of molecular disturbance thus made visible is identical with the invisible layer of molecular pressure, and afterward by experiments of various kinds he essays to establish the fact that these molecules whose impact upon the sides of the glass tube occasions evolution of light are sensitive to magnetic influence, and that the amount of deflection in the current or stream of light depends upon the amount of magnetic power employed, thus modifying the well-known law of the directness of the rays of light.

The whole theory depends upon a degree of rarefaction of the gas or air in

the tube which never can be experienced in reality, and without which this fourth state of matter cannot exist, since its peculiarity consists merely in the reduction of the number of molecules in the tube by rarefaction or exhaustion of the air, or gas therein, until the properties which constitute the ordinary gaseous state, which depend upon constant collisions among the molecules, are reduced to a minimum and the matter becomes exalted to an ultra-gaseous state, in which the corpuscular condition of light may be detected, and in which light does not always move in a straight line. These phenomena, Prof. Crookes concludes, in these exhausted tubes we can never experience, but must be content to observe and experiment with from the outside. In brief, it seems to be the Professor's idea that air or gas may be so attenuated in a vacuum tube that by means of magnetism light may be rendered visible in a bodily form, and may be diverted by the same means from a straight line, and also that its attenuation may be so extreme, or, in other words, its molecules or particles so reduced in number or quantity, that there will not be enough of them left to furnish the conditions of gaseity, and consequently the fourth state, that of the ultra-gaseous, will be present.

GARY'S MAGNETIC MOTOR.

It is only necessary to mention something new in mechanics speedily to raise a mushroom crop of the original inventors of that very idea. Thus the announcement of Miss Hosmer's alleged discovery of a magnetic motor has brought forth various claimants to a like invention. None of them, however, are as specific in description of their new motor as Wesley W. Gary, of Boston. Mr. Gary's invention rests first on the discovery of a neutral line in the magnetic field of a permanent or common horseshoe magnet, in front and on either side of the two poles at a distance therefrom proportionate to the size and strength of the magnet, and the thickness of the armature brought into the field to be affected by magnetic action. This neutral line may be said to be the place where the polarity of the magnetic forces, under the given circumstances, is balanced, so that the armature, or any piece of soft iron, which in the magnetic field of a permanent magnet is made a magnet by induction, when exactly in this line, if of a size and thickness rightly proportioned to the size of the magnet, has no polarity, will neither attract nor repel, but appears to have the magnetic influences from the permanent magnet so balanced in itself that, if a magnet still, it exerts no magnetic forces. This neutral line is the leading fact which makes the other facts of Mr. Gary's discovery possible. Secondly, the armature, or piece of soft iron, when in the field of the permanent magnet, although exhibiting no magnetic force, while exactly on the neutral line, instantly possesses polarity and will attract or repel when moved ever so little off from this line, whether toward or away from the magnet. Thirdly, and what is most remarkable, when moved from this line nearer to the magnet, yet not in contact with it,

the armature has polarity the same as the magnet, but when moved from, or across, the neutral line further away from the magnet, it has polarity opposite to that of the magnet. This change of polarity in the armature, produced simply by change in its position, and produced instantly and as often as its position is changed from one side to the other of the neutral line, is the fact that makes the magnetic power available.

THE PHONEIDOSCOPE.

An instrument with the above-mentioned name was presented to the Societe Francaise de Physique, at its last sitting, by the inventor, M. Taylor. Its object is to show, optically, the delicate peculiarities of sonorous vibratory movement. A thin film of liquid glycerine is formed on a small opening made in a piece of blackened brass, and it reflects the light of a lamp in producing either on the retina direct or by production on a screen, the well-known iridescent effects of the transparent plates. As long as the film is motionless, the simple colors of iridescence are alone visible. But if, by means of a bent tube, the vibrations of a sustained sound are conducted underneath that film, by the voice or otherwise, the film begins to vibrate and the colors are distributed geometrically, producing on the surface fixed bands and moving rings, the disposition of which varies with the depth of the tone and the nature of the harmony accompanying it—that is to say, the pitch. M. Taylor showed, by projection, that the acoustic figures thus obtained become more and more complicated as the tone emitted rises, or when, the height remaining constant, different vowels are pronounced. The colors thrown on the screen differed during the experiment in proportion as the film became thinner by evaporation, but the acoustic figure did not vary. The results obtained are extremely curious and of varied appearance, according as apertures of different forms are used. M. Taylor projected the phenomena produced by openings triangular, round and square, by means of the Drummond light. The considerable heat which accompanies that process of lighting causes, after a certain time, the evaporation of glycerine, and terminates the experiment. But its duration may be augmented by passing the luminous rays through a glass flask filled with water, which deprives them of the greater portion of the qualities absorbable by the liquid glycerine.

THE WALLED LAKE IN IOWA.

The greatest wonder in the State of Iowa, and perhaps any other State, is what is called the "Walled Lake," in Wright County, twelve miles north of the Dubuque and Pacific Railway, and 150 miles west of Dubuque City. The lake is from two to three feet higher than the earth's surface. In some places the wall is ten feet high, and fifteen feet wide at the bottom, and five feet wide on top. Another fact is the size of the stones used in construction, the whole of them

varying in weight from three tons down to one hundred pounds. There is an abundance of stone in Wright County, but, surrounding the lake to the extent of five or ten miles, there are none. No one can form an idea as to the means employed to bring them to the spot or who constructed it. Around the entire lake is a belt of woodland half a mile in length, composed of oak. With this exception the country is a rolling prairie. The trees must have been planted there at the time of the building of the wall. In the spring of the year 1866 there was a great storm, and the ice on the lake broke the wall in several places, and the farmers in the vicinity were obliged to repair the damages to prevent inundation. The lake occupies a ground surface of 2,800 acres; depth of water as great as twenty-five feet. The water is clear and cold; soil sandy and loamy. It is singular that no one has been able to ascrtain where the water comes from nor where it goes, yet it is always clear and fresh.—*Dubuque Herald.*

HONORS TO THE LATE PROF. HENRY.

On the afternoon of January 16th, in the National House of Representatives, memorial services in honor of the late Professor Joseph Henry were held in the presence of a vast audience. The President and his Cabinet, Chief Justice and Associate Justices of the Supreme Court, the United States Senate, the alumni of Princeton College, and members of the various societies with which Professor Henry had been associated occupied seats on the floor, as did also a number of ladies. After the opening prayer by Dr. McCosh, of Princeton, addresses were delivered by Vice-President Wheeler, after reading the address of Senator Hamlin, who was unable to be present, President Withers, Professors Gray, of Harvard, and Rogers, of Boston, Representatives Garfield and Cox, of New York, and General Sherman. Prayer was then offered by Rev. Byron Sunderland, and the invited guests having retired, the House adjourned.

ENGLISH ADVICE FOR COLD WEATHER.

The London "*Medical Press and Circular*" says: "We are in the midst of a severe winter, and as hygiene is the order of the day, we cannot be too particular in impressing upon the public certain facts which are too often disregarded. Few are aware of the killing powers of the intense cold and great heat, even in this comparatively temperate climate. Those who have been in the habit, as we have, of watching the returns of the Register-General, well know how quickly the death rate rises during even a short continuance of cold weather. Now, the fact that the increase in the mortality affects chiefly the young and old, as well as those who are either suffering from or are predisposed to, affections of the chest and throat, indicates the class of people who should be especially careful to protect themselves against the inclemency of the weather. With regard to children,

the system of hardening them by allowing them to go thinly clad and exposing them to all sorts of weather, is a delusion from which the minds of some parents are even now not altogether free. It is thought that if their chests are kept warm, there is no need of caring about their arms and legs. But this is a mistake. In proportion as the upper and lower extremities are well clothed will the circulation be kept up and determined to the surface of those parts, and in proportion to the quickness and equable distribution of the circulation will be the protection against those internal congestions which are but the first stage of the most fatal disease of infancy and childhood. The same observation holds good with respect to grown-up people who are predisposed to pulmonary complaints. There is no exaggeration in saying that the mortality from those and other affections would be considerably diminished were people to avoid that "catching cold" of which they so often and so lightly speak; and it is a matter of surprise to us that this fact, of which most of us are aware, does not lead to more precautions being taken by those who are anxious about either their own health or that of others. To take care that the body is thoroughly warm and well clothed just before going out in very wet or cold weather—to keep the circulation and warmth of the body rather by exercise of some kind than by sitting over great fires or in over heated rooms—to be sure that the temperature of the sleeping apartment is not ever so many degrees below that of the sitting room, these are three golden maxims, attention to which would prevent thousands from catching that chill or "cold," to the results of which so many valuable lives have been prematurely sacrificed.

THE MINERAL SPRINGS OF COLORADO.

Idaho Springs is one of the oldest of Colorado watering places, and possesses, in an eminent degree, the characteristics and surroundings of a popular health and pleasure resort. Located thirty-four miles from Denver, by rail, in the valley of South Clear Creek, it is sheltered from the winds, and at an elevation of 7,800 feet above the sea, has a most delightful and health giving climate; surrounded by high and well-known land marks which, like the "Old Chief," "Squaw," and "Papoose," lift their heads from 10,000 to 11,000 feet; possessing a number of medical springs, impregnated with iron, lime, soda, sulphur and magnesia; provided with ample hotel accommodations; surrounded by picturesque drives and walks, Idaho Springs possesses many advantages over other Colorado resorts. Its proximity to Denver, Georgetown, Central and other interesting mining and business communities; its large and well-conducted swimming baths; its eight soda springs—unite to render it one of the most attractive spots in Colorado and a favorite resort for invalids and tourists who come for rest and comfort.

In the language of a tourist whose travels have led him to all the prominent pleasure resorts and watering-places of Europe, as well as of this country, Idaho

Springs is, perhaps, for the tourist, the most celebrated resort in Colorado. Easy of access from Denver; 7,330 feet above the sea level; the location of some of the most efficacious mineral springs in the State; surrounded by scenery bold, grand and novel, it attracts a large and increasing throng of visitors. No tourist should come within a day's journey of Idaho Springs, without enjoying the satisfaction of a plunge in its famous swimming baths, the largest of which, the "Mammoth," is thirty by fifty feet in size, and five feet in depth; the hot soda water, which pours in from the spring, being regulated to suit the bathers of the season; connected with it is a large shower-bath, comfortable dressing rooms, a barber shop, and all necessary appliances. The sensation produced by a plunge in this warm, soda water bath is peculiarly delightful, and, for rheumatic affections, wonderfully efficacious.

A short distance from the above is a smaller swimming bath, the "Ocean," twenty by forty feet, and four feet in depth, generally used by ladies, who form into pleasant parties from the hotels and generally bathe in the evening. This is also fitted with a cold shower-bath, comfortable dressing rooms, and is provided with polite female attendants. The medicinal properties of the baths are considered equal, and, by very many, superior to Baden, Ems or Weisbaden, of Germany. There are private bath rooms, where the natural temperature of the water at 110°, can be enjoyed.

Near Soda Creek there is a cold soda spring which is strongly impregnated with sulphur, and is very effervescent and sparkling, and makes a delicious beverage. Dr. I. G. Pohle, of New York, made a chemical analysis of the water from the Hot Soda Springs, and found it to yield the following constituents, in the annexed proportions, to the gallon:

Carbonate of Soda	30.80
Carbonate of Lime	9.52
Carbonate of Magnesia	2.88
Carbonate of Iron	4.12
Sulphate of Soda	29.39
Sulphate of Magnesia	18.72
Sulphate of Lime	3.44
Chloride of Sodium	4.16
Chlorides of Calcium and Magnesium, of each, a trace..	
Silicate of Soda	4.08
Grains	107.08

—*Colorado Tourist.*

FLOWER SEEDS FOR SPRING PLANTING.

If you have no experience, select the kinds most easily grown, such as Asters, Balsams, Petunias, Zinnias, Dianthus, etc., with only a few of the more difficult. Great care should be had to select seed suited to the purpose for which they are designed. If we wish to cover a fence or veranda quickly, the Morning

Glory or Nasturtium, or some of the free-growing, hardy climbers should be chosen. If the object is a showy bed on the lawn or the border, in addition to the bedding plants, such as the Geraniums, the Petunias, the Phlox Drummondi, the Verbena, and such flowers as continue in bloom a long time and make a gay show of colors, are desirable. For taller flowers, a back-ground in the garden, the Zinnia, Marigold, Gladiolus, and flowers of this character should be selected. For cutting for small bouquets there should be some beds of Mignonette, Sweet Peas, Alyssum, and other fragrant flowers, with the fragrant-leaved Geranium.—*Vick's Floral Guide for 1879.*

THE AXOLOTL NOT A DEVELOPMENT LINK.

Another sensation is likely to be created among evolutionists by the discovery of Dr. Weisman, of Freiburg, that the axolotl, whose change from a fish form to that of an air-breathing lizard has been hailed as an unmistakable proof of the development theory, really never makes this change except under forced conditions, and when it does so reverts to a lower form; since, after such a change, it loses the power of reproduction, while the axolotl itself if left in its native waters breeds freely, reproducing its own form and species only.

Professor Stanley Jevons urges the importance of at once undertaking direct observations of the varying power and character of the sun's rays, asserting that, while hundreds of meteorological observers are registering at every hour of the day and night the most minute facts about the atmosphere, the very influence upon which all atmospheric changes ultimately depend, the *solar radiation*, is not measured by any of them, at least not in the proper manner.

NO DYSPEPSIA IN OLD TIMES.

Benjamin Wolsey Dwight states in his "Memoirs of the Connecticut Academy of Arts and Sciences" (1811), that dyspepsia is a modern disease in this country, and was scarcely known until the present century. This he attributed to the paucity of carriages up to that date, whereby both sexes were compelled to travel on horseback; the fact that, so far as men were concerned, by far the greater part combined some agricultural work with their other avocations, and that patent bitters and other stomach destroying stimulants were not in existence.

A VOLCANO DISCOVERED IN KANSAS.

A peculiar phenomenon is reported about twelve miles north of town in the bluffs. A man was out there hunting rabbits, and while there he noticed a lot of smoke coming from one bluff, and he went to it. To his astonishment he dis-

covered that the smoke was issuing from a large hole in the ground, and also the ground was so warm that the snow had melted from the bluff. The smoke still continues, and there is some excitement in that neighborhood, the people believing that a volcanic eruption or an earthquake is imminent. Our informant is truthful, and he will give the scene a visit to-morrow to investigate the matter. —*Cawker City Free Press, Jan. 11.*

EDITORIAL NOTES.

THE Kansas City Academy of Science met Dec. 31, 1878. The room was filled, President Van Horn in the chair.

Judge E. P. West read a very interesting paper upon "The Footprints of Primitive Thought," which was attentively listened to, and afterward freely criticised and discussed. It will be found in full in this number of the REVIEW.

Theo. S. Case read the usual monthly abstract of Scientific Progress, after which Professor Greenwood demonstrated orally that The centrifugal force on the Earth's surface decreases as the square of the cosine of latitude from the equator to either pole, being one of the questions announced for discussion at the last meeting. The other question as to the connection between the maxima and the minima daily variations of the barometer and the magnetic needle, was, at the request of Professor Parker, made the subject of discussion for the next meeting.

T. S. Case, in behalf of H. C. Lea, of Philadelphia, presented to the library of the Academy a handsome octavo copy of Rodwell's Dictionary of Science, which, on motion was placed in charge of the Librarian, and the Corresponding Secretary directed to tender the thanks of the Academy to Mr. Lea.

At the next meeting papers will be read by Prof. C. E. Robbins, of Summit, Colorado, and Mr. Greeley, of this city. Col. Van Horn, being necessarily absent from home, will read his paper at the (February) meeting.

Professor Greenwood was appointed to prepare and read the monthly summary of scientific progress at the next meeting, which will be held on the 4th Tuesday of this month, January 28th.

ARRANGEMENTS are in progress to celebrate in some sufficiently important way at Penzance the centenary of Sir Humphrey Davy's birth. The great chemist was born at Ludgvan, near Penzance, in Dec. 17th, 1788, and was educated and served his apprenticeship to a surgeon in that town, where he acquired the rudiments of the science in which he has become so distinguished.

PROFESSOR PALMIERI, who has devoted his life to the study of Mount Vesuvius, has an observatory situated on a long and narrow ridge of rock on Mount Catroni, almost at the foot of the actual cone of the volcano, half a mile from the Hermitage of San Salvatore, the extreme point to which carriages can ascend the mountain. In spite of the risks, the Professor has remained at his post, and chronicled features of the eruptions of the last six years.

MR. DAVID ECCLES, of this city, in a well written communication to the *Times*, concerning the alleged recent discovery of the compound nature of the so-called chemical elements, calls attention to a letter received by him from his brother, Prof. R. G. Eccles, of Brooklyn, N. Y., some three years since, in which the professor clearly points out the remarkable structure of some of the homologous groups in organic chemistry, as well as the peculiar allotropism of certain classes of the inorganic elements. It is an article of no ordinary interest, and just at the present time, when the discoveries of Lockyer are agitating scientists everywhere, it will be read with avidity by all.

At the last meeting of the Leavenworth Academy of Science, which was held on January 9, a paper was read by W. S. Burke, editor of the *Western Homestead*, upon the "Impending Revolution," of which the Leavenworth *Times* gives the outline, as follows:

The speaker took up the subject of the bearing of labor-saving machinery upon the labor markets of the world, and undertook to show that since machinery had enabled a portion of the working force of the community to supply the physical wants of the whole, it would be necessary to educate the taste for the ornamental and the beautiful, to make a greater demand for something beyond the strictly useful, in order to furnish employment to a larger proportion of the people in lines of work not directed especially to supplying the physical wants of mankind.

At the next meeting, January 23, Prof. G. E. Patrick, of the State University, will read an essay entitled "Chemistry in the Arts."

The phenomenon of a beautiful rainbow in the zenith of the heavens, forming a complete circle, attracted general attention about eleven o'clock this forenoon and set the scientific heads to pondering. It was a strange sight to see at a time when such phenomena are unusual, and particularly on a day when the necessary element of water in the heavens did not exist. Let us hear from learned minds on the subject.—*Atchison Patriot, Jan.* 8.

The phenomenon was evidently that known as a "halo," which is explained upon the hypothesis of snow or ice-crystals falling slowly in a calm atmosphere, and is due simply to the refraction of the solar rays upon crystals of ice, producing all around the sun, and at the same distance, a series of luminous impressions. Flammarion, in his work on The Atmosphere, gives a very full and minute explanation of the whole subject.

DR. EDWIN R. HEATH, of Wyandotte, Kansas, whose interesting description of the Antiquities of Peru appeared in the November number of the REVIEW and has been widely copied, sailed from New York Nov. 18, for Peru, intending to complete the exploration of South America commenced by Professor Orton, an undertaking he is well fitted for from inclination and experience.

IT is reported that a Brooklyn inventor, after years of experiment, has constructed an electric engine. The machinery necessary to run an ordinary sewing machine needle through any thickness of cloth is contained in a small box eight inches square and four inches deep. A small battery furnishes the electricity and may be at any distance from the machine, the distance governing the size of the wire connecting the two. The expense is small, as the battery is the only constant expense, and this costs only a few cents a day while in use. The speed at which the machine is run and the stopping and starting are entirely under control of the operator, being governed by a switch on the cloth plate. Its successful working has been shown in public.

SINCE our last issue a very important educational association, known as the Missouri Valley Teachers' Association, has held a session of three days in this city. Several of the essays read before it were of the highest order. We are only enabled to present our readers with one of them, that of Professor Nipher, of St. Louis, in this issue, but hope at some future time to obtain others. At nearly the same time the Southwest Missouri Teachers' Association was in session at Springfield, Mo., and according to the local papers it was equally interesting and important with that held here.

KANSAS CITY received one-fifth as many hogs at her stock-yards in 1878 as there are in all England, and more than one-sixth as many cattle as there are in Great Britain. That will do very well for a live-stock market only eight years old.—*K. C. Journal.*

The *Mining Record* says that during the ten months of 1878 ending October 31, the excess of imports over exports of gold and silver coin and bullion was in England $16,820,000, of which only $194,000 was silver, the remainder—$16,626,000—being gold; in the United States $6,016,869, of which only $1,138,565 was gold, the remainder—$4,878,304—being silver; in France, $62,534,000, of which $21,162,000 was silver, the remainder —41,344,000, being gold.

THE Kansas Historical Society proposes to erect a statue of Hon. Eli. Thayer, as a perpetual memorial of his services in behalf of the freedom of that State.

THE articles of Judge West, of this city, and of Rev. Noah Porter, of Yale College, published in this number of the REVIEW, may be regarded as fair examples of the extremes of antagonistic reasoning, and as such we commend them to the careful consideration of earnest and thoughtful readers.

ITEMS FROM THE LEADING PERIODICALS.

WE present our readers in this number an abstract of Prof. Lockyer's much-looked-for paper on the compound nature of the elements, taken from the *London Chemical News*, by which it appears that the alleged discovery is the result of spectroscopic rather than of chemical observation. Since, as has been well said by *Iron*, "it is easy to frame a plausible spectroscopic theory to the effect that complex spectra are built up of simpler spectra, and that, therefore, the elements giving complex spectra are probably built up of the elements giving the simpler ones," we perhaps had better await further proof before acknowledging that our entire system of chemistry must be revised.

The *American Naturalist*, (McCalla and Stavely, Phila.) contains as usual a complement of excellent and interesting articles; notably, those by Prof. Baird, on the Breeding habits of Eels, Lieut. Vogeles on A Lost Race in America, Alfred W. Bennett on The Absorption of Water by the leaves of Plants, etc. To us the general notes are always attractive and "full of meat" Among them in the January number we observe an item taken from Prof. Brooks' report announcing that *Lingula*, a Brachiopod which has hitherto been credited with resisting development, evolution and change of any kind from the remotest fossiliferous ages, has upon closer study, been found to have "transmitted to its children a developmental record which proves that *Lingula* itself is the *descendant of a much older form.*" *Nil disputandum.*

The valuable series of articles on House-building in the *Boston Journal of Chemistry* continues into 1879, and gives additional value to that popular periodical.

Dr. H. Carrington Bolton of Trinity College, Hartford, Conn., contributes to *Science News* of January 1st, 1879, an interesting description of the new elements discovered since 1877, viz: Davyum, discovered by Kern and named after Sir Humphrey Davy; Mosandrium, discovered by Prof. Lawrence Smith, of Louisville, Ky., and named after the Swedish chemist, Mosander; Phillipium, discovered by De La Fontaine and named after M. Phillipe Plantamour, of Geneva; Yterbium, discovered in the earth yttria by Prof. Marignac, of Geneva; Decipium, discoved by De La Fontaine and so named because of its deceiving qualities, (from *decipio*) to deceive.

Appleton's Journal opens the year with an excellent number replete with good articles. Fiction, history, hygiene, science and art, all find place in its pages, and add to its value as a family magazine. It has ceased to be an illustrated periodical, which we think a mistake, and devotes its space to the best articles to be found in the current literature of the day.

The *Journal of the Franklin Institute*, among other valuable matter, including the continuation of Dr. Hoffman's exhaustive series of articles upon the Development of the Chemical Arts within the last ten years, gives space to an elaborate description of an Automatic Tit-tat-to Machine, with seven wood cuts and several diagrams and tables, by Frank G. Freeland, and closes with the usual "Items," which embrace brief abstracts by competent writers, of scientific articles on all current topics.

M. Darlincourt having recently perfected a telegraphic instrument, which transmits messages in the actual hand writing of the sender, the *London Telegraphic Journal* of December 15th, gives *fac simile* copies of such dispatches, as well as a copy of a landscape sketch transmitted over the lines between London and Birmingham.

The *International Review* has introduced an innovation in review literature, in the way of a tale by Wilkie Collins, called A Shocking Story. For this the editors will be thanked by many of their readers and found fault with by others, who, when they buy a periodical with a Turveydrop title, want "deportment" and nothing else. However, they cannot find much to complain of, as only twenty-nine pages out of one hundred and eighty four are given to the story, while the remainder are filled with articles of the best quality by some of the ablest writers of the day. We regard the Book Reviews of the *International* as especially full and reliable. With the year 1879 it follows the example of the *North American* and becomes a monthly at the same price as heretofore.

The *Popular Science Monthly* comes to us this month, enlarged to 144 pages and apparently improved and increased in every respect except price, which remains as formerly, notwithstanding that the Monthly has absorbed the *Supplement*, and consequently ought to be worth twenty-five cents more than heretofore. Among the many excellent articles none have interested us more than Prof. Carhart's Astronomical Magnitudes and Distances; M. F. Maury's Black Diamonds, and Molecular Dynamics by L. R. Curtiss. Living fully up to its name, it is the most popular Science Monthly in this country.

The Literary World (E. H. Hames & Co., Boston), always sprightly and entertaining, and at the same time reliable and just in its comments upon new books, changes form with the January 4th issue, becoming a fortnightly instead of a monthly, and raising its subscription price to $2.00 per annum. It will increase its attractiveness by publishing a series of "Short Studies of American Authors," by Mr. T. W. Higginson. These papers will be both critical and descriptive, but their subjects will not be announced in advance.

The *Sanitarian* devotes some twenty-three pages to the Yellow Fever discussions of the American Public Health Association at Richmond, Va., Nov. 1878, and thereby presents to its readers the most complete compendium of practical information yet published on that important subject.

The *North American Review*, since its removal to New York City, seems to have laid aside some of its pristine massiveness and taken on a new life and activity, better adapted to the modern times and practices. This is especially noticeable in its change with the commencement of the new year from a bimonthly to a monthly, with price unchanged. The January number contains a number of fresh, timely articles, political, historical, critical and financial. Among the most interesting are those of Senator Edmunds upon the Canadian Fishery award, W. W. Story upon The Pronunciation of the Latin Language and Capt. Howgate descriptive of the Cruise of the Florence.

The Gardeners' Monthly for January, 1879 pays a fitting tribute to the memory of the late Dr. J. H. Klippart, for so many years Secretary of the Ohio State Board Agriculture and also well known through his labors in botany and horticulture. His health has been feeble for some years, but he worked on unremittingly and at last literally wore himself out in his devotion to scientific studies.

The Engineering & Mining Journal commences its twenty-seventh volume with several important improvements, such as a regular Record of progress in science and the arts a popular epitome of Scientific news and progress in Mechanics, also a monthly supplement devoted exclusively to the Coal and Iron trade and other matters pertaining thereto. In doing this it incorporates with itself the *Polytechnic Review*, being the third periodical it has absorbed within the past few years, and making it without doubt the best journal of its class in the country. The admirable illustrations contained in the issue of December 21st have been largely commented upon by the papers everywhere, and deservedly so, for so far as we have observed they have not been equalled by any other periodical in the United States.

XUM

That the publishers of *The Atlantic Monthly* intend to maintain the high character of the magazine in all departments during the year 1879 is fully shown by their programme for the coming volumes. The most able writers will treat of topics of political, economical and social interest; serial and short stories by the best American authors will be given; and the admirable critical papers, transatlantic sketches, studies in art and history, etc., which have been found so attractive in the in the past, will be continued.

Sunday Afternoon, for January, reached us in good season and proves to be just what a family needs for the relaxation of mind among the weary old folks and the quiet entertainment of the younger ones. All of its articles are original and have a healthy, moral tone, while discussions of religious subjects always form a portion of its contents. It numbers such well-known writers as Prof. Francis A. Walker, Rev. Leonard W. Bacon, Elizabeth Stuart Phelps, Rose Terry Cooke and many other familiar popular essayists.

Among all of our literary exchanges, few give us as much gratification in the reading as *The Library Table*. Its Briefs on New Books are kept fully up to the times, which is no small matter in the flood-tide of fresh literature of the present day—and they are keen, faithful and impartial. Next to the review feature, come Literary news and Records of new books, which afford just the information needed by readers and students. A few pages are always devoted to fiction, and the serial tale, "Rutherford," now occupying that portion of the magazine, is exceptionally interesting and well sustained. The chapter of Contents of Periodicals is, of itself, almost equivalent to an index of the leading scientific, religious, medical and literary journals of the day.

Besides the very valuable archæological article on "The Origin of Metallurgy," which we are reproducing from *Van Nostrand's Magazine*, the January number contains one on "The Physics of the Missouri River," in reply to Capt. Eads; a most valuable one on "Sanitary Science in the United States," by Prof. A. R. Leeds, Ph. D.; a compilation of the history of Electric Light, and a number of others equally important, but more strictly technical.

Prof. Dascombe Greene, of Troy, N. Y., describes in the *American Journal of Science and Arts*, for January, a paper dome, devised by him, for an astronomical observatory. It is a hemisphere of paper stretched over a wooden frame, with an outside diameter of twenty-nine feet, and vertical height of about ten feet. It is composed of sixteen equal sections, which were formed over a model, covered with paper about one-sixth of an inch in thickness, and thoroughly painted. These sections were then placed in proper position and bolted together and the joints properly closed against the weather An opening left at the top was also covered with a shutter of paper, treated in the same manner. The whole dome, weighing 4,000 pounds, rests on six 8-inch cannon balls which roll between grooved iron tracks, and is easily moved by moderate pressure without the aid of machinery; whereas, a dome of similar size, constructed in the usual manner, would weigh from five to ten tons and require the aid of cumbersome machinery to revolve it.

Prof. E. T. Nelson, of the Ohio Wesleyan University, is editing the Scientific Department of the *Farm and Fireside*. published at Springfield, Ohio, and writing a series of popular articles on Conchology, which will be of the greatest sevice to those who are fortunate enough to read them.

Prof. Geo. Reuling M. D. gives in the *New York Medical Journal* a most careful and precise description of his manner of operating for cataract by removing the crystalline lens with its capsule uninjured, all other operations only aiming at the extraction of the lens alone, leaving the enveloping capsule *in situ* and more or less obstructing vision.

All of the above periodicals can be had at a good discount through the publisher of the Kansas City Review, and any book published by any leading house in the country, at advertised rates, postpaid.